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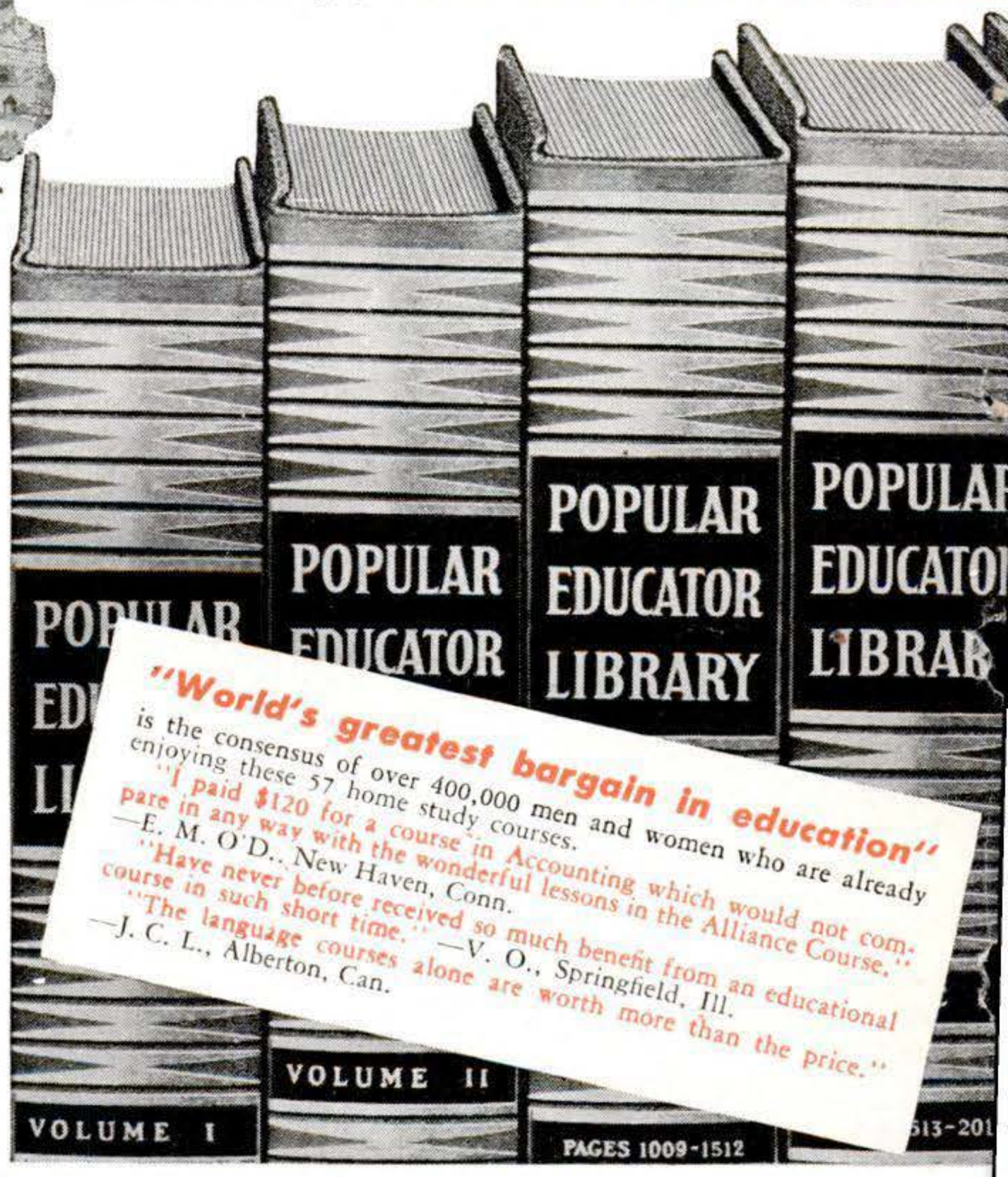

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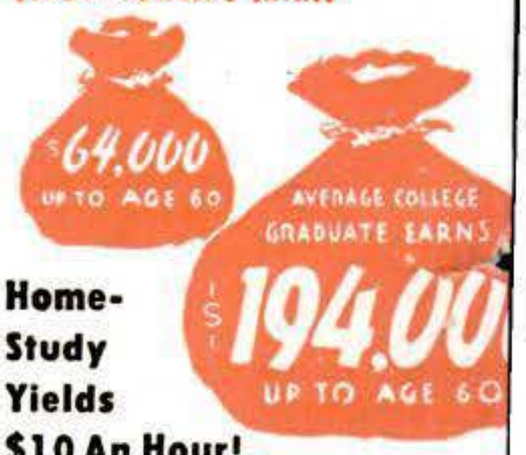

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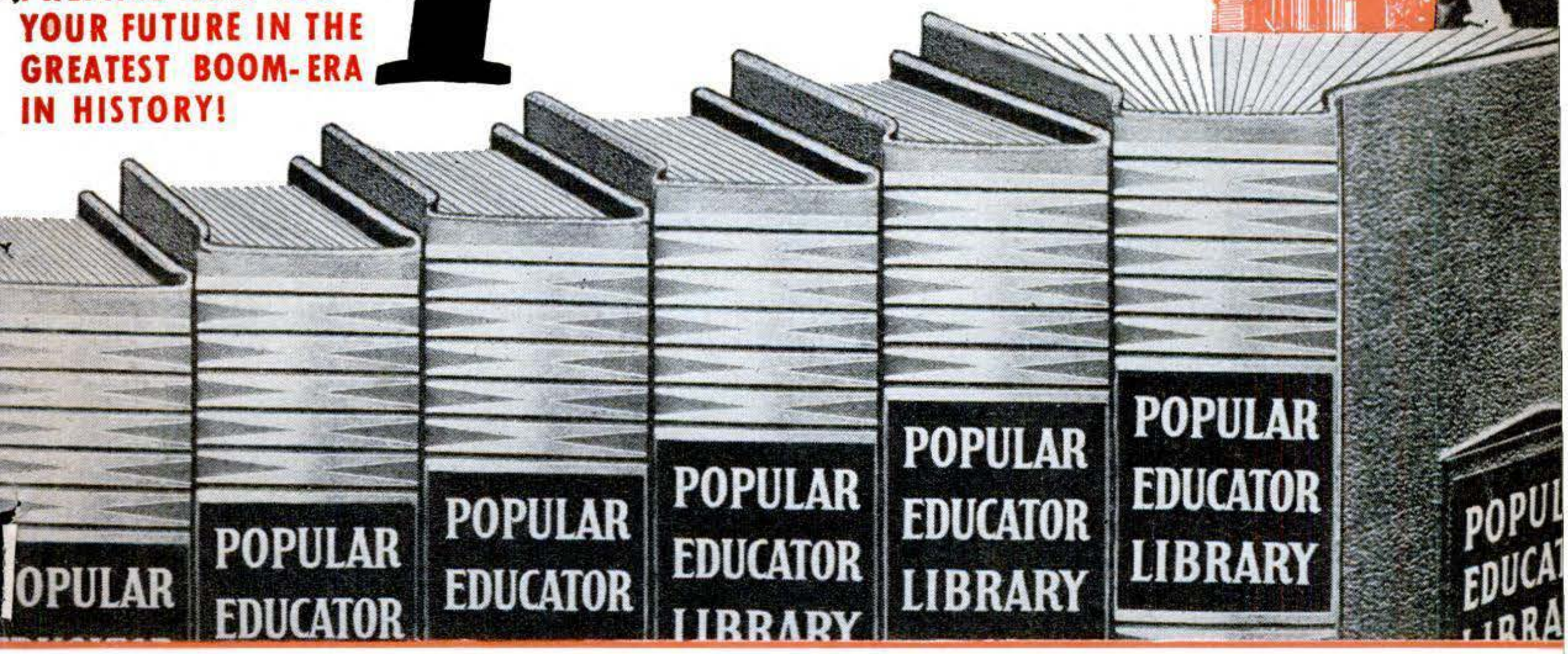

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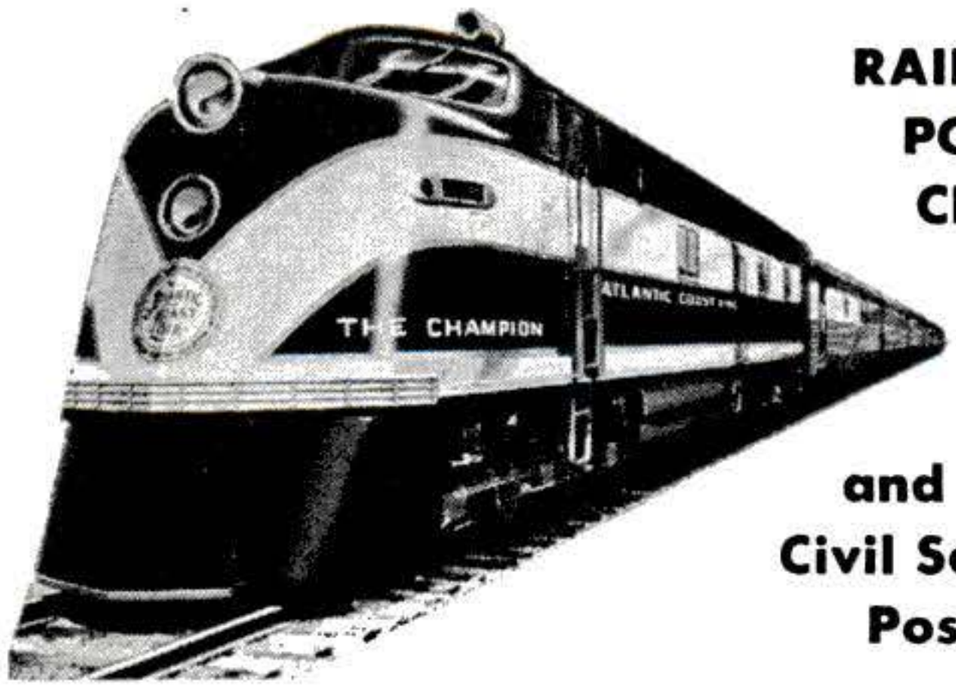

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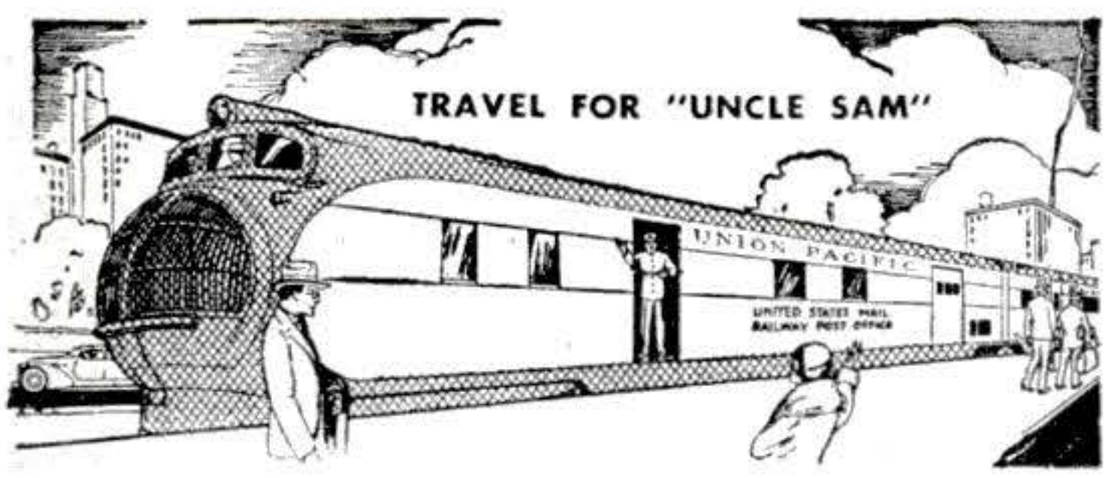

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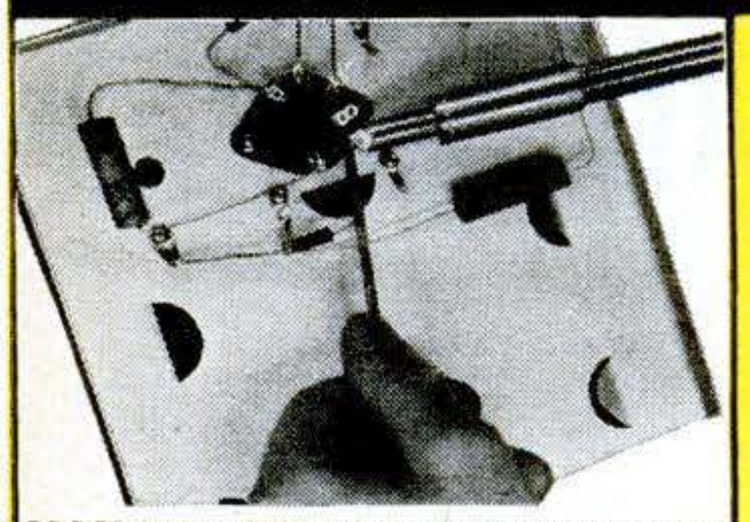

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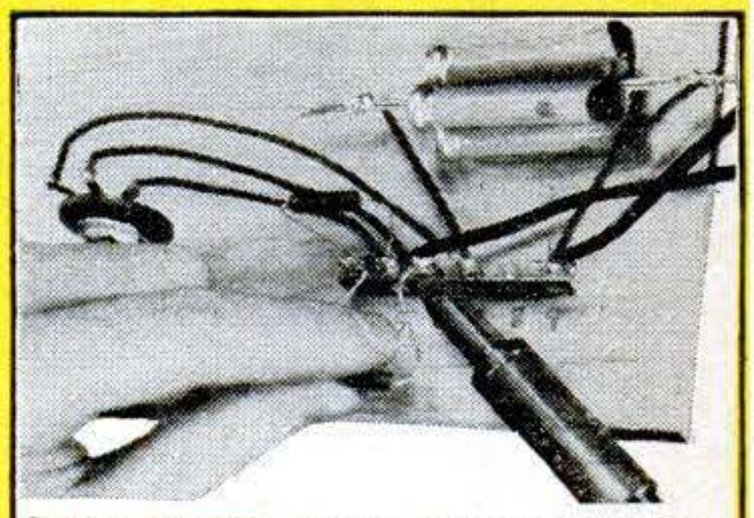

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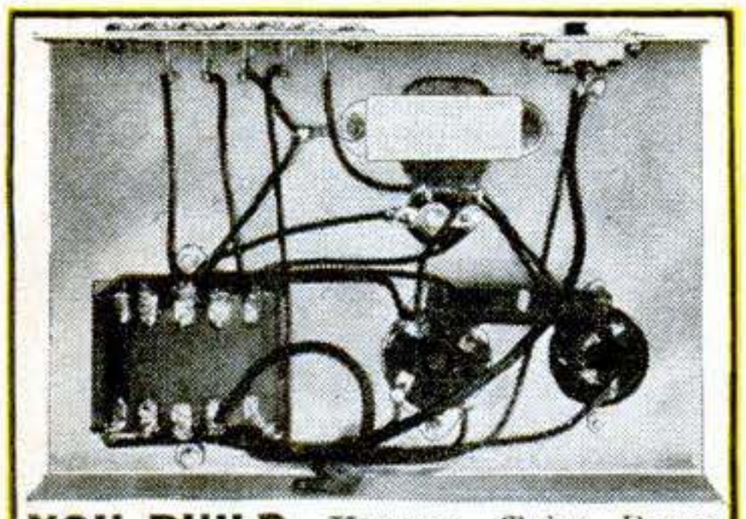

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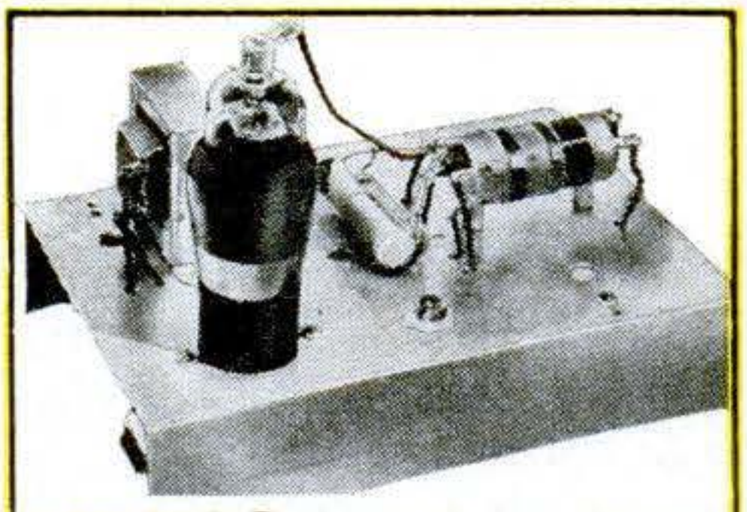

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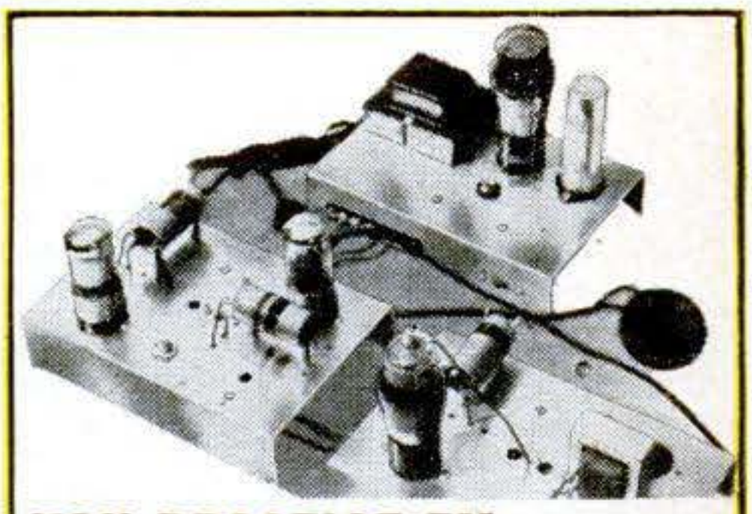

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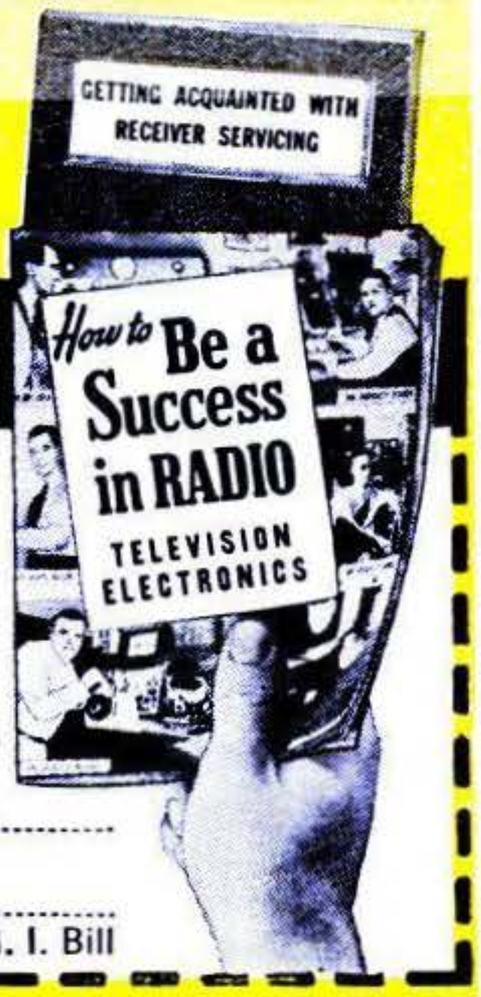

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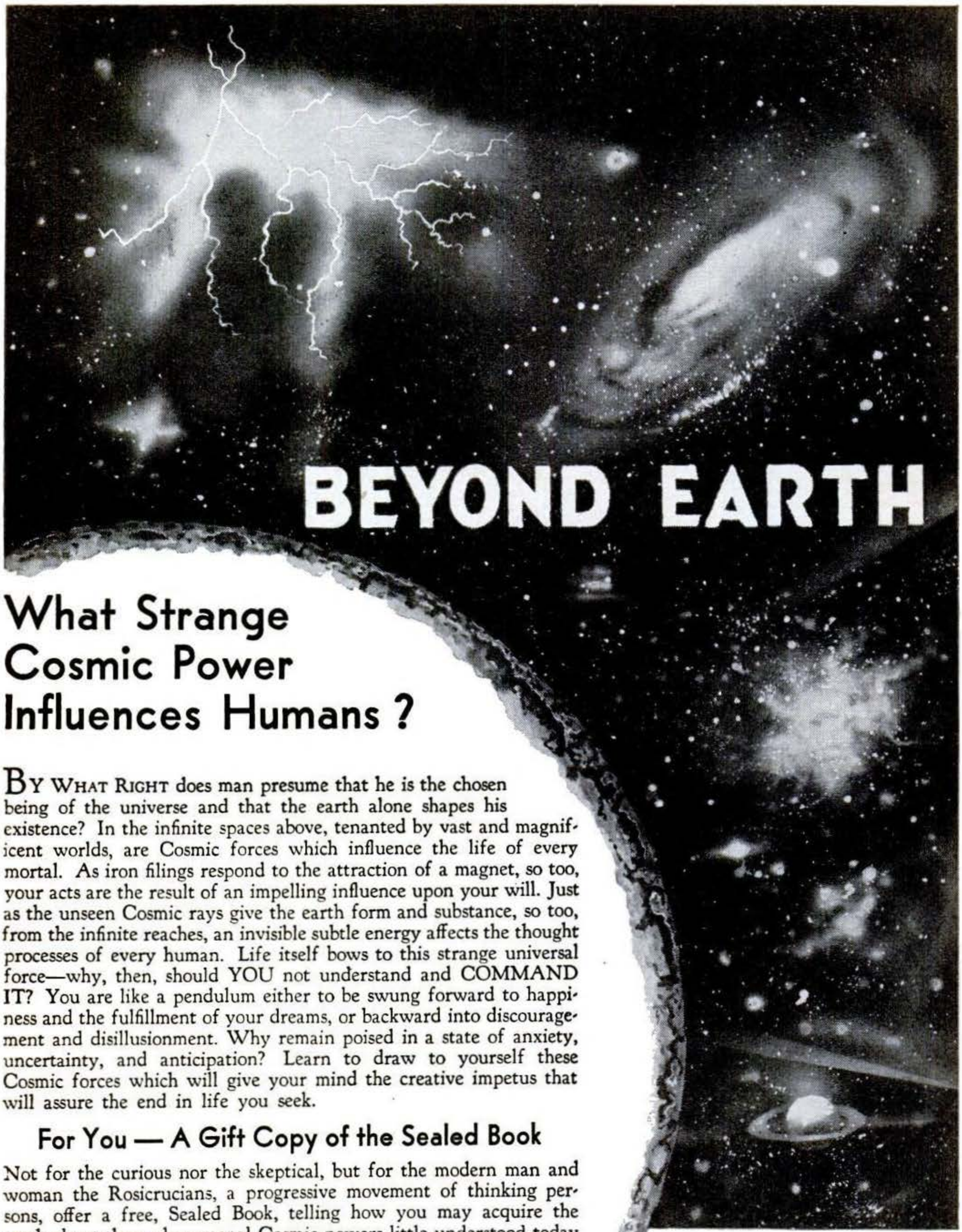

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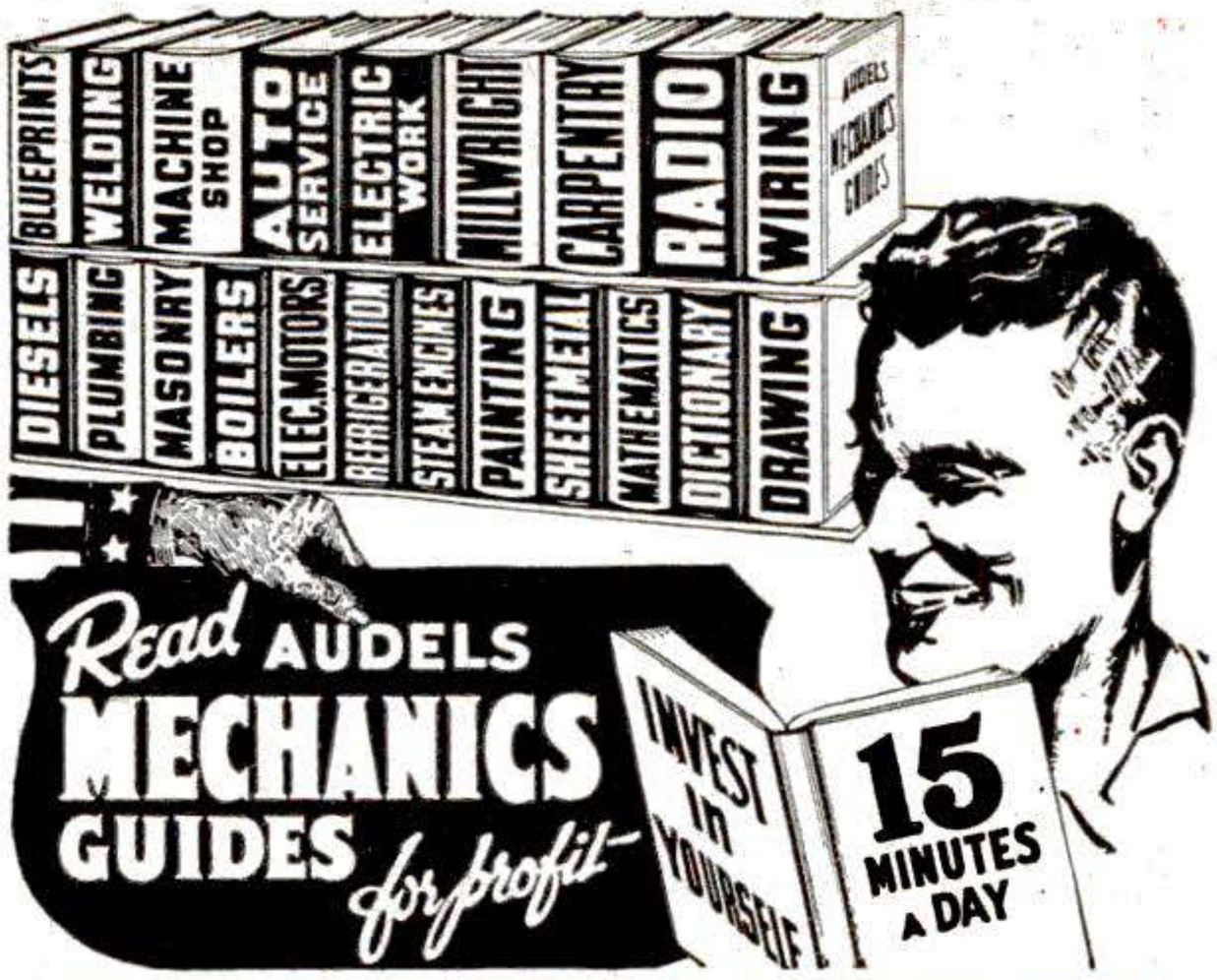

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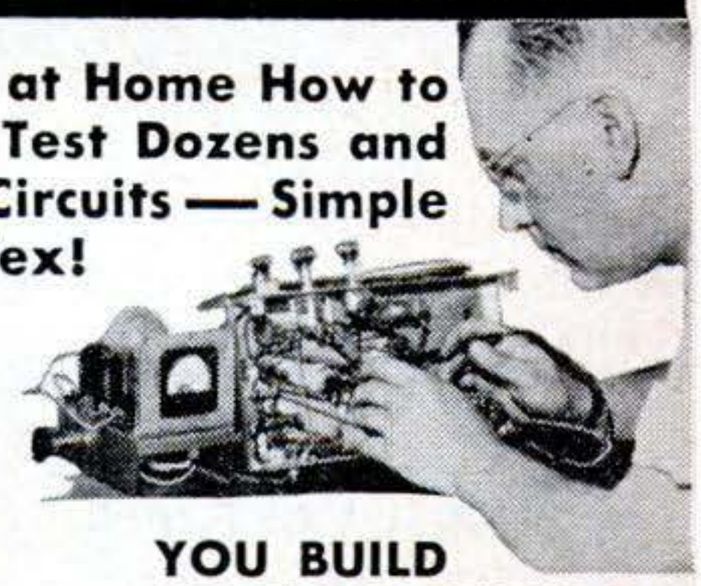

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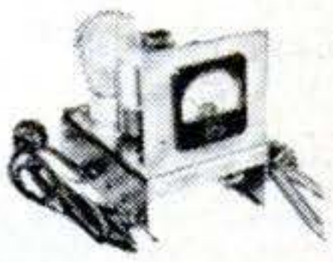
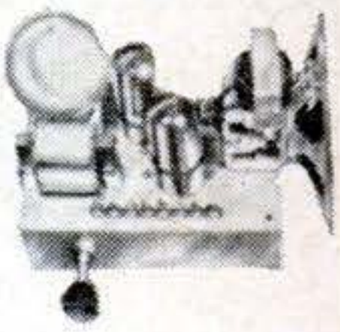
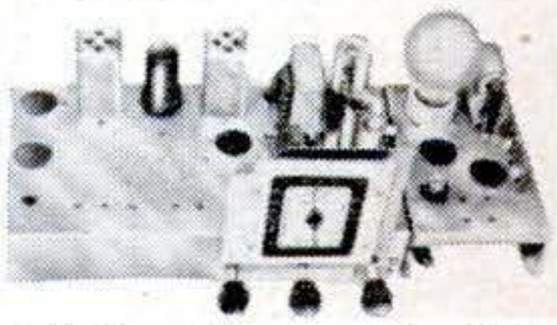


I give you a fine, moving-coil type Meter Instrument on Jewel Bearings — with parts for a complete Analyzer Circuit Continuity Tester. You learn how to check and correct Receiver defects with professional speed and accuracy.



You'll get valuable experience and practice building this Signal Generator and multi-purpose Tester. Makes a breeze out of fixing Radios and you don't have to spend money on ready-made Equipment.



Soldering, wiring, connecting Radio parts . . . building circuits with your own hands — you can't beat this method of learning. When you construct this Rectifier and Filter, Resistor and Condenser Tester, etc., you get a really practical slant on Radio that leads to a money-making future.

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A patent gives the inventor the exclusive right to prevent others from making, using, or selling the invention claimed in the patent for a period of seventeen years.

The Patent Laws were enacted for the benefit of the inventor to give him protection for the features of his invention which are patentable. These features must be properly and concisely set forth and claimed in a formal application for patent, in order to comply with the requirements of the Patent Laws. For that reason, unless the inventor is familiar with patent matters, he should engage a competent registered patent attorney or agent to represent him. We are registered to practice before the U. S. Patent Office and are prepared to serve you in the handling of your patent matters.

A specially prepared booklet entitled "Patent Guide for the Inventor", containing detailed information with respect to patent protection and procedure, together with a "Record of Invention" form will be promptly forwarded to you without obligation upon request.

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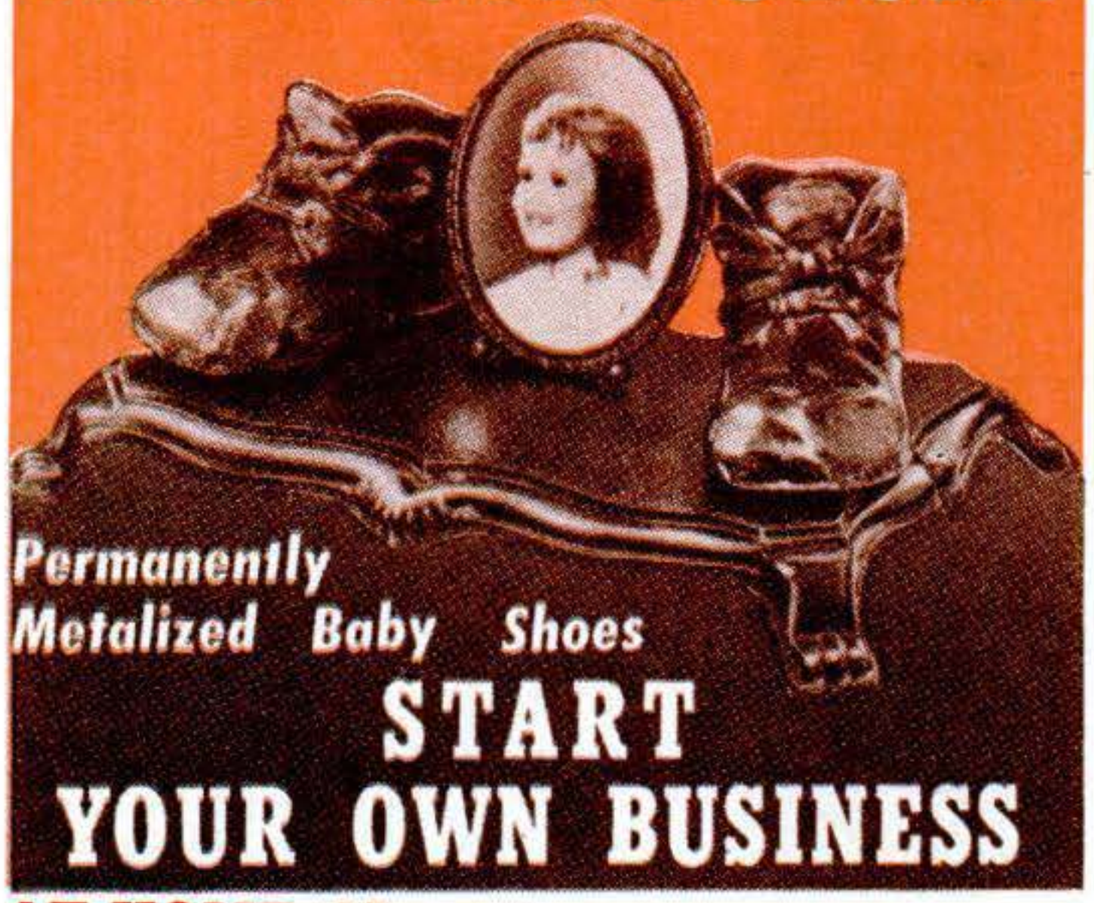

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Letters

The Lindbergh Letter—Pro and Con

Maybe you do not agree with Col. Lindbergh, but I certainly do. He was only trying to tell this chaotic world that the only way to real and lasting peace is to return to the religion and faith of our forefathers.

WHITNEY J. YOUNG

Kokomo, Ind.

. . . Please advise your circulation department to cancel my subscription, as I do not care to find spiritual values attacked as you have done in an environment unsuited to such.

JOHN D. HENRY

Flushing, N. Y.

. . . It seems to me that, while some of Lindbergh's ideas could be more wisely phrased, you have misinterpreted his intention, which was not to criticise the scientific spirit, nor to personify science as an embodiment of evil, but to point out that science cannot take the place of religion, and that the use of the products of science must be controlled by moral force which springs from religious insight.

(Mrs.) FRANK POTTER

Charlotte, Vt.

Your remarkably forthright, courageous letter has won me to PS for life. . . It is writing like this that demonstrates the unselfish search for truth and the welfare of one's neighbor.

MORRIS ISAACSON

San Lorenzo, Calif.

Your editorial is to be commended highly. It is another strong argument for the idea that scientists can no longer isolate themselves from society but must, like other citizens, take part in the struggle for man's mind which men, not science, are waging.

J. L. GROSS

Los Angeles, Calif.

PS has been a member of my monthly "musts" until the October issue. Your open letter to Col. Lindbergh has impressed me as being more devastating in its moral and spiritual attack on human souls than has

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The firm of McMorrow, Berman and Davidson is registered to practice before the United States Patent Office. Additionally it engages patent attorneys able to readily understand inventors' disclosures, to advise concerning patentability, and to prepare appropriate specifications and claims.

If an inventor believes he has an invention, a search of the most pertinent prior U. S. patents should be made and a report obtained relative to its patentability. Where such report indicates that the invention appears patentable, in order to secure protection, diligence should be exercised in making application for a patent.

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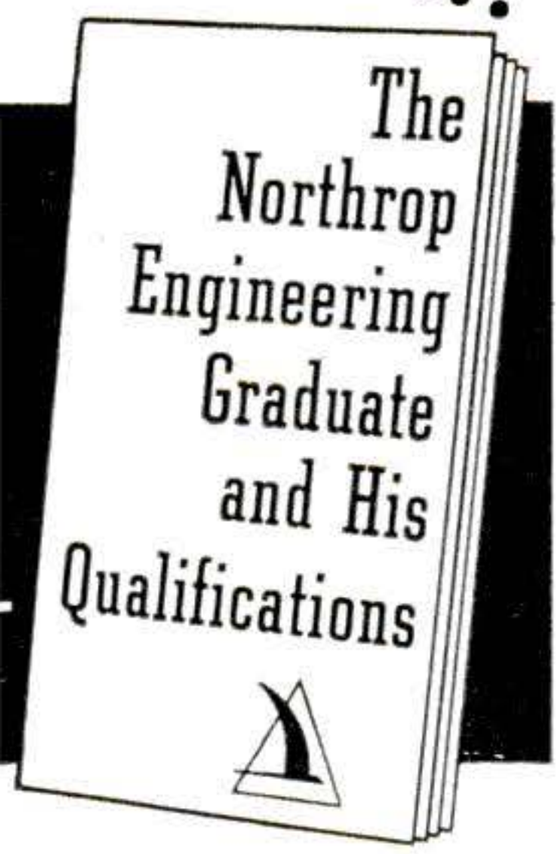

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been the atom bomb, of which you lovers of Science are over-proud. . .

Science, in my opinion also, must be controlled, for Science is striving not to "better humanity," as you would have people believe, but rather, our scientists are striving to attain levels of human reasoning which their God-given minds were not intended to attain.

REV. DIMITRY S. KUDRIKOFF

Scranton, Pa.

. . . I believe Lindbergh's writing is as far superior to yours as his flying would be.

E. L. MCGILL

Greeley, Colo.

. . . I say thanks to Colonel Lindbergh for his book. For, if it had not been written your very fine editorial probably would have never materialized . . . I feel that your criticism helps all to obtain a firmer grasp on their sense of values.

FRANK H. FRY

Philadelphia, Pa.

Your attack on Col. Lindbergh is altogether unjustifiable. He is not attacking science; he is only pleading for a right view of science. . . If you have an answer to him it would be more becoming to publish it on his own scholarly level, instead of resorting to a cheap journalistic tirade which is evidently little more than cheap publicity seeking.

LAWRENCE ROSSITER

Hartington, Neb.

Congratulations on your letter. It was excellent! More of this type of precise, scientific thought should be used in a world where "half truths which are whole lies" are so prevalent.

FRANK BARFUSS

Jackson Heights, N. Y.

Three cheers for your splendid letter to Col. Lindbergh. . . It is not unlikely that it will be reprinted 75 years from now together with that of your distinguished predecessor.

J. ALLEN YAGER, M. D.

Paterson, N. J.

. . . There is only one group of scientists who accept moral responsibility for their discoveries, the medical profession. How well we are protected from the injurious use of drugs! When other scientific groups accept a similar moral responsibilty, then, and then

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only, will all of science work for man's benefit.

MURIEL E. JOLLOW

Brandon, Manitoba

. . . No, Lindbergh is not confused, but you confounded. Evil forces don't make themselves but are the products of mankind's unrestrained jealousies, hatred and fears . . . you may kid and confuse yourself but not the PS readers who have read Lindbergh's book.

ROBERT F. MANIFOLD

Philadelphia, Pa.

. . . . The paragraph of Mr. Lindbergh's book which you chose to attack is absolutely true. Mr. Lindbergh does not say that science is not good; he says that man's misuse and misdirected emphasis is bad, and I agree with him. To discuss the dangerous aspects of a bull doesn't mean that he isn't good to eat.

FRANK S. CHRISTIAN

Boston, Mass.

Heartiest congratulations on your sane and stable letter to Col. Lindbergh.

As long as such clear voices as yours can reach wide audiences in this country, we still have a democracy.

Let's hope both science and democracy continue to develop in this country without faltering . . . Thanks for being alert and pointedly intelligent.

L. R. HAYMAN

Cleveland, O.

. . . . I wholeheartedly agree with you, and I do not see how Col. Lindbergh can blame science for the state of the world. Science is produced by man, and therefore how can science be blamed for anything? . . .

After reading your idea I felt much safer, and erased from my mind the thought that the world would soon be utterly destroyed.

JANE RYLANDER

Chowchilla, Calif.

Still a Firetrap

Sir:

I have read in the October issue about the fire-fighting equipment and safety ("Your Home: Your Own Firetrap!" p. 98). But nothing about building with materials that will not burn. Why do we tear down

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INVENTORS

Unless an inventor is thoroughly familiar with such matters, he is advised to employ a competent registered patent attorney or agent as the value of patents depends largely upon the skillful preparation of the specification and claims.

For his guidance, the following are the usual preliminary steps which the inventor takes toward patent protection.

The "Evidence of Invention" form mentioned below is offered as a convenience to the inventor in making his disclosure of invention.

The inventor should date and sign his disclosure and have it witnessed by two or more persons who are capable of understanding his invention. The disclosure should then be mailed to the registered patent attorney or agent whom he selects to assist him. The disclosure should be accompanied by a letter authorizing the patent attorney or agent to conduct a preliminary search among previously granted U. S. patents for similar types of invention. The patent attorney or agent then prepares a report of the probable patentability of the invention and recommends the further course the inventor should take, provided the report indicates possible patentability.

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our forests to build firetraps when there are all kinds of materials that are capable of being used to build that are fireproof? . . .

The very existence of up-to-date fire prevention is evidence that we are afraid of fire. If we built of fireproof materials, we would lose that fear. . .

I am building a house in spare time that has no wood in its construction. It is cheaper and absolutely fireproof. Earth walls and concrete roof and floor. . .

ERNEST R. CALLEY

Carmel, Calif.

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Putting Nature to Work

Sir:

Having long been keenly interested in heating homes by utilizing the energy of nature, a few lines in the November "Letters" section, page 18, arrested my attention: "There is some promise in MIT's new high efficiency thermocouples, which convert heat directly into electricity. . ."

My studies concerning this subject lead me to believe that when someone properly combines the sun-trap (solar heating) in the south wall with a bank of thermocouples in the north wall, no other source of heat will be necessary for a home, even through the coldest winter. . . . The electrical output of the thermocouples should be connected to a resistance-type heating element that is strung along the north wall near the floor so its rising heat warms the wall. . . .

Automatically, the colder it becomes outside, the greater becomes the temperature difference between the hot and cold junctions of the thermocouples, and the warmer it becomes inside. It works just as well at night and in cloudy, sunless weather when the sun-trap must depend upon storage or "tank" capacity, and it can be shut off when the sun-trap is fully saturated. . . .

GEORGE A. GERBER

Roselle, Ill.

Work on a heating system using thermocouples is already under way, but the main trouble at present is that the best of MIT's thermocouples are still not efficient enough to compete with conventional heating systems. When these and methods of solar heating are perfected, Mother Nature will indeed heat your house for you.

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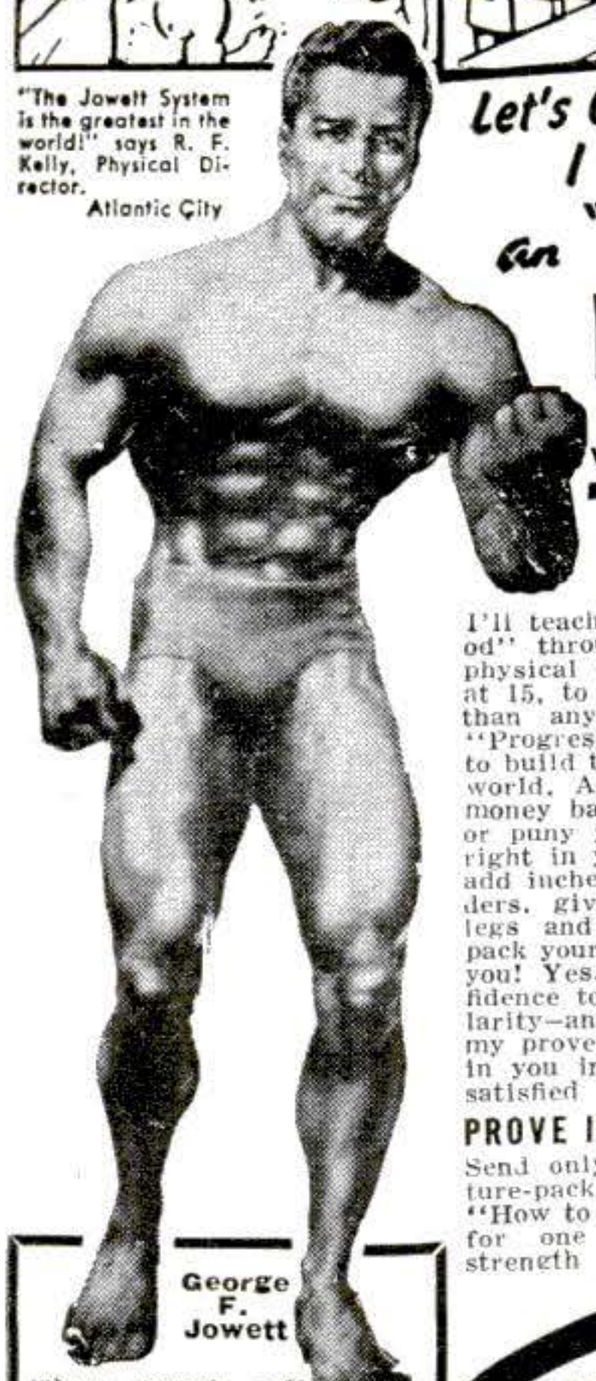

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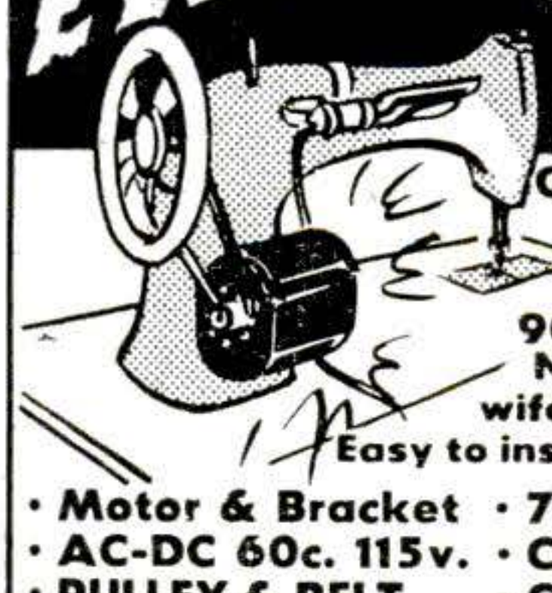

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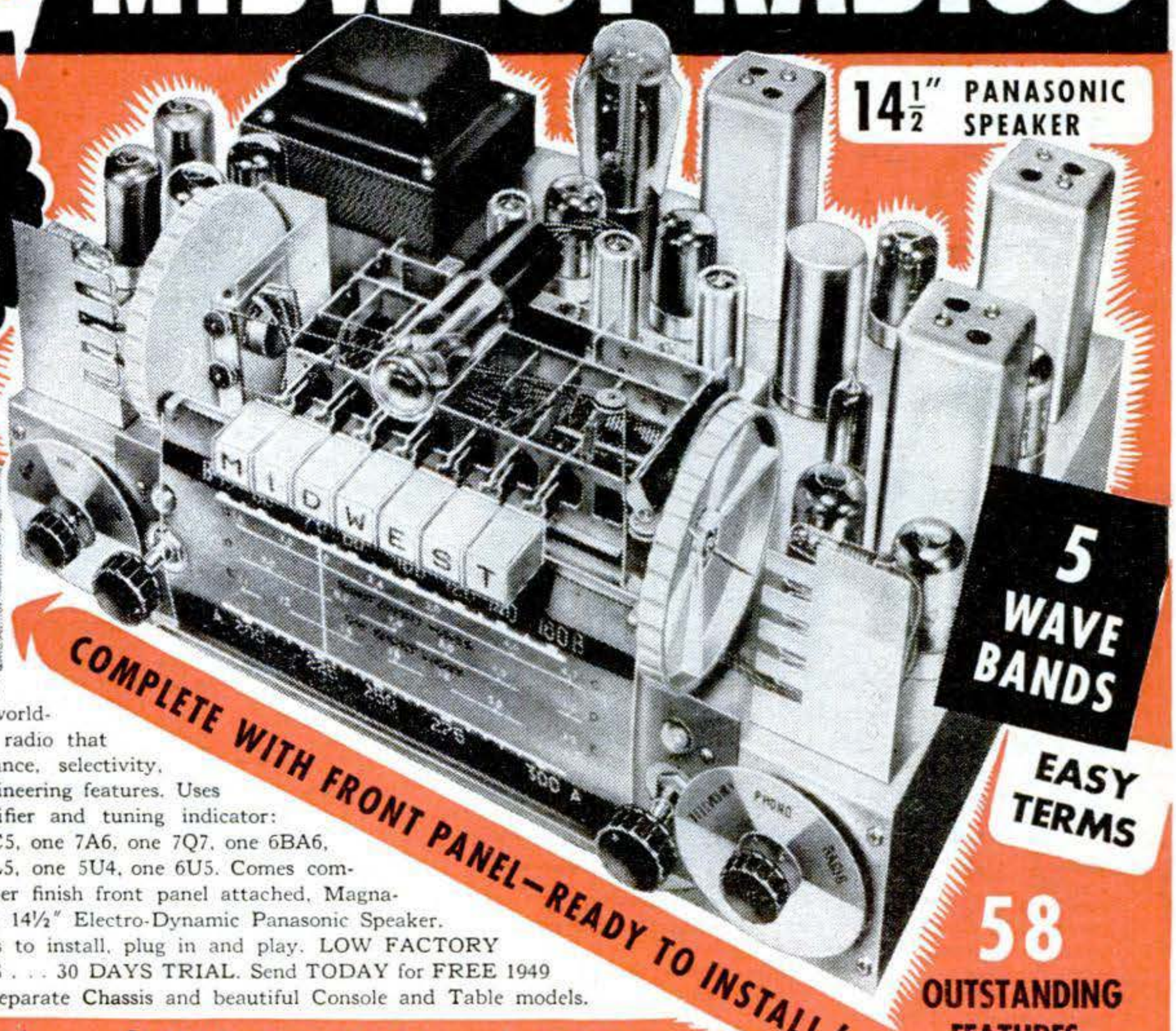

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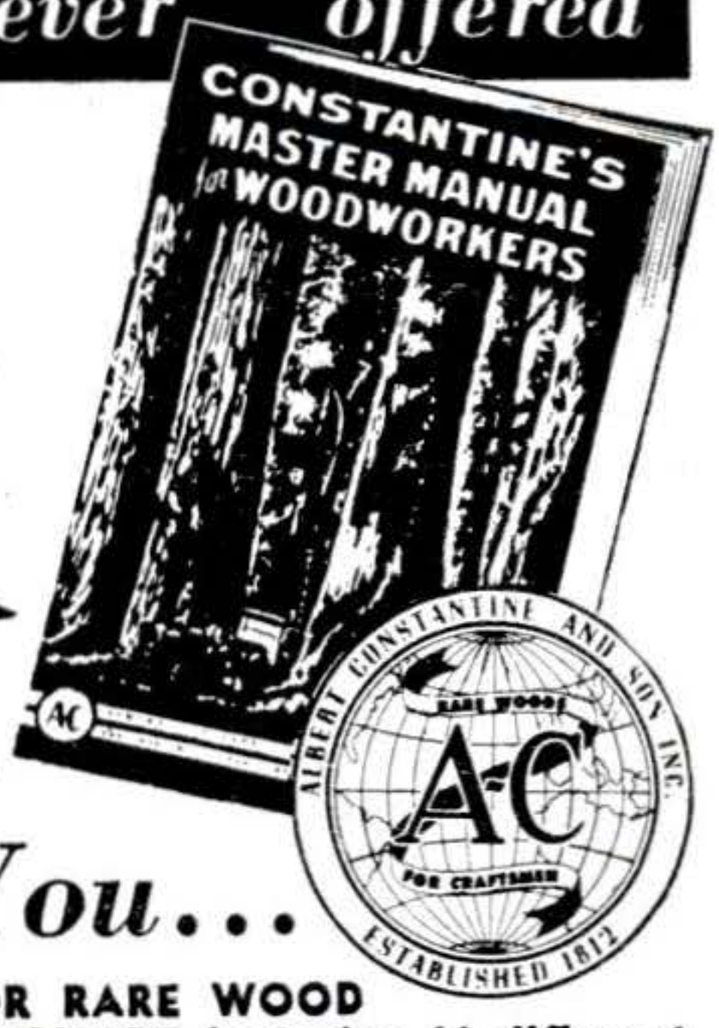

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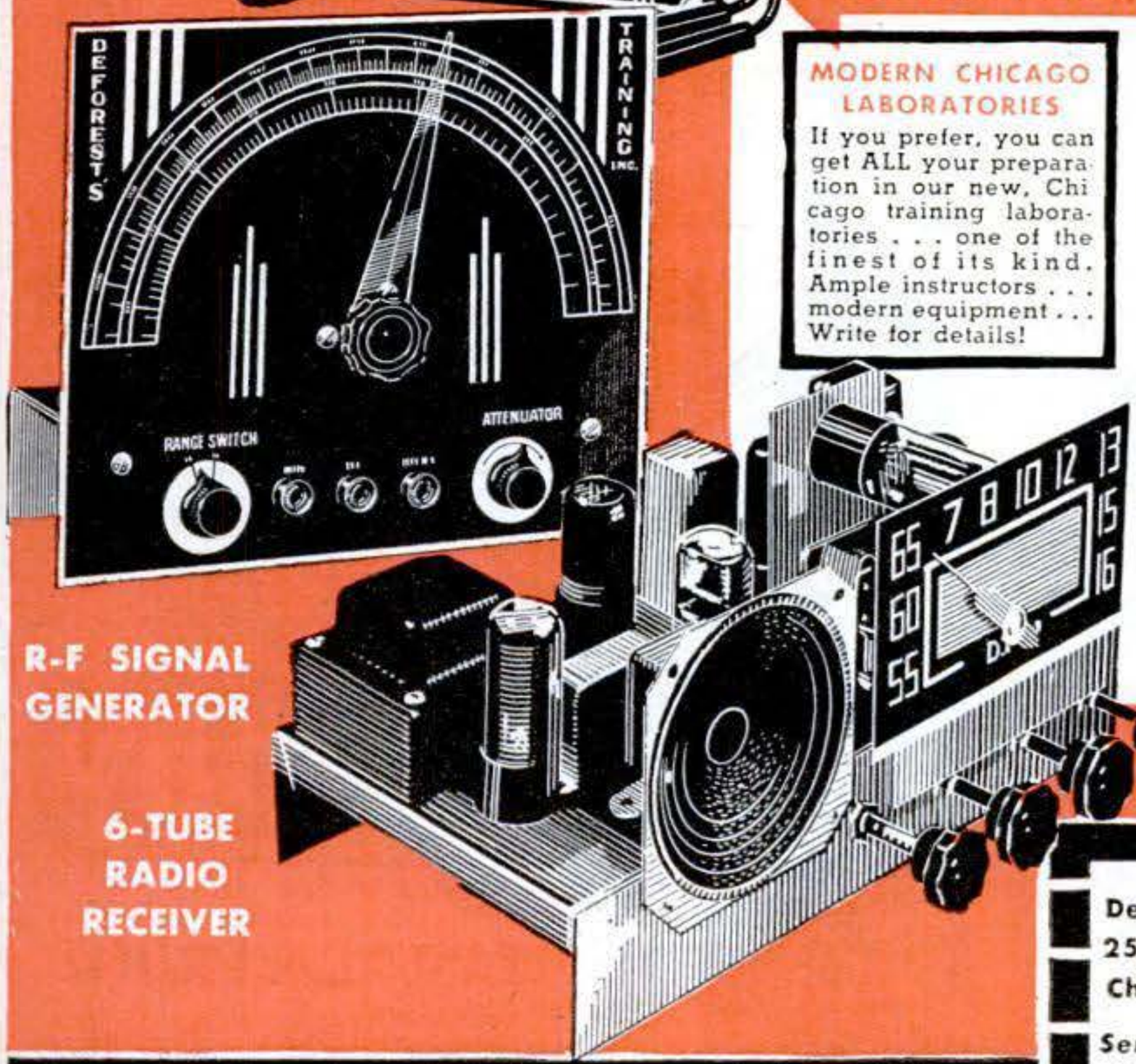

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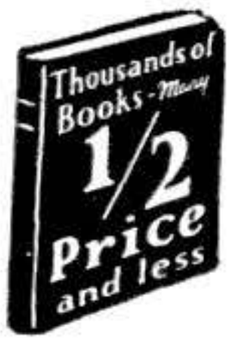

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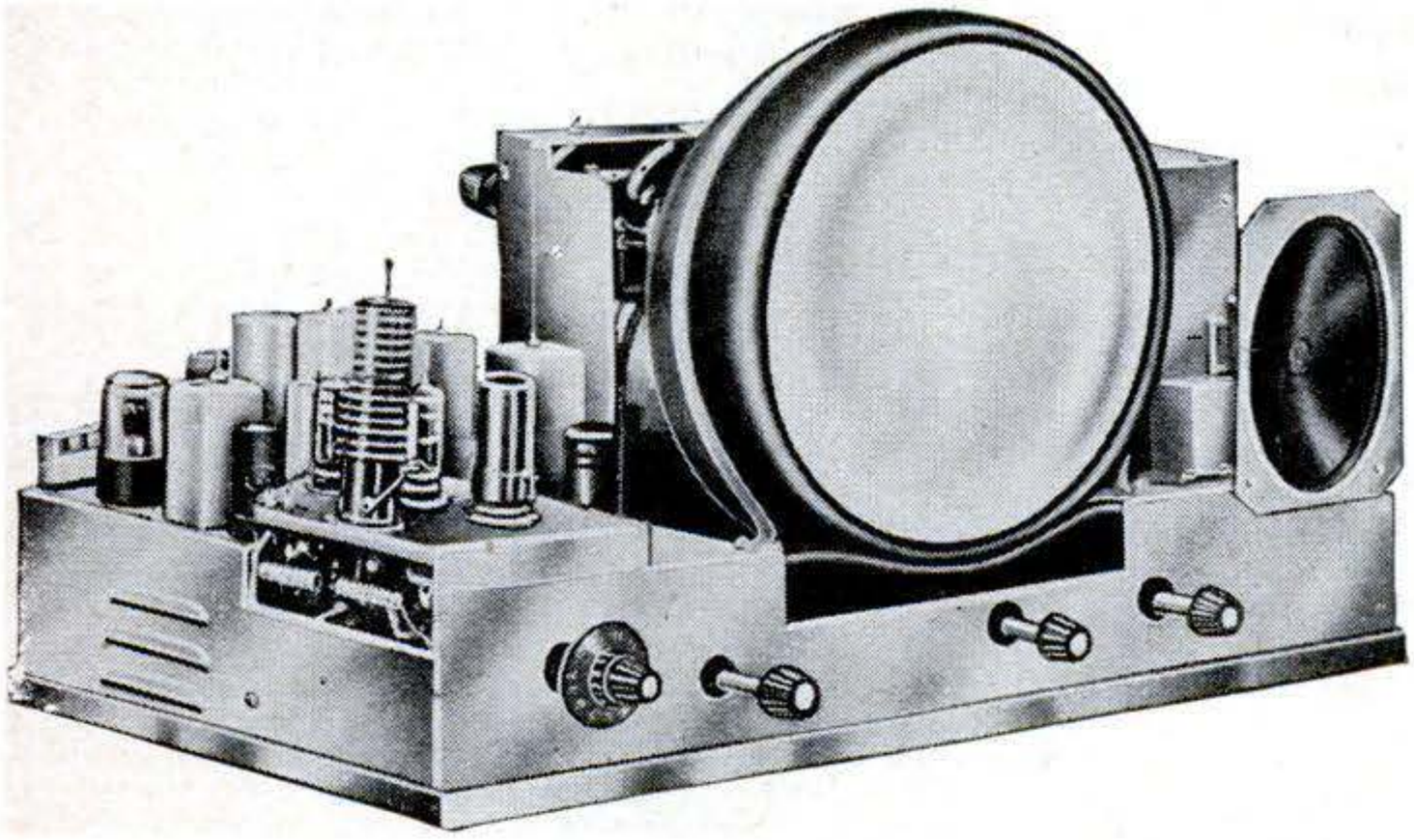

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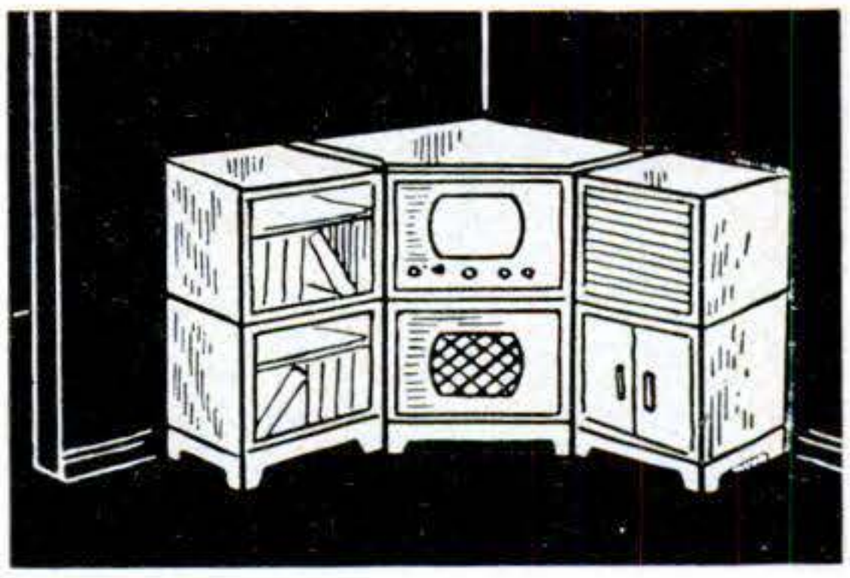

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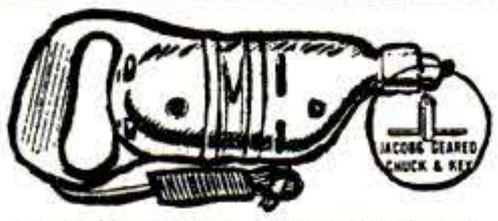

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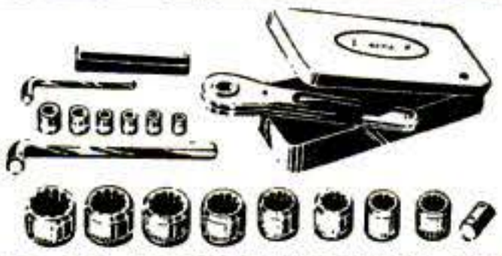

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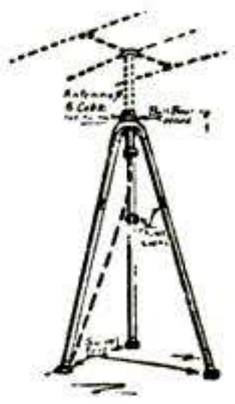

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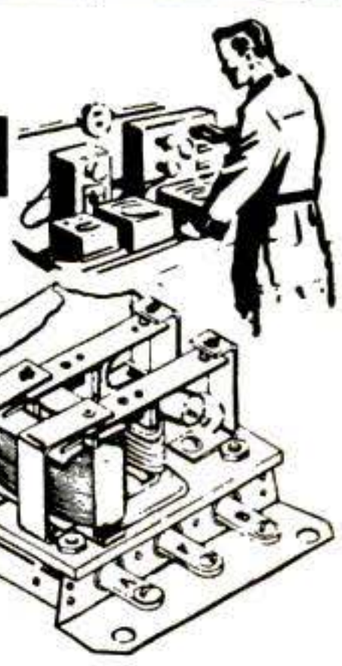

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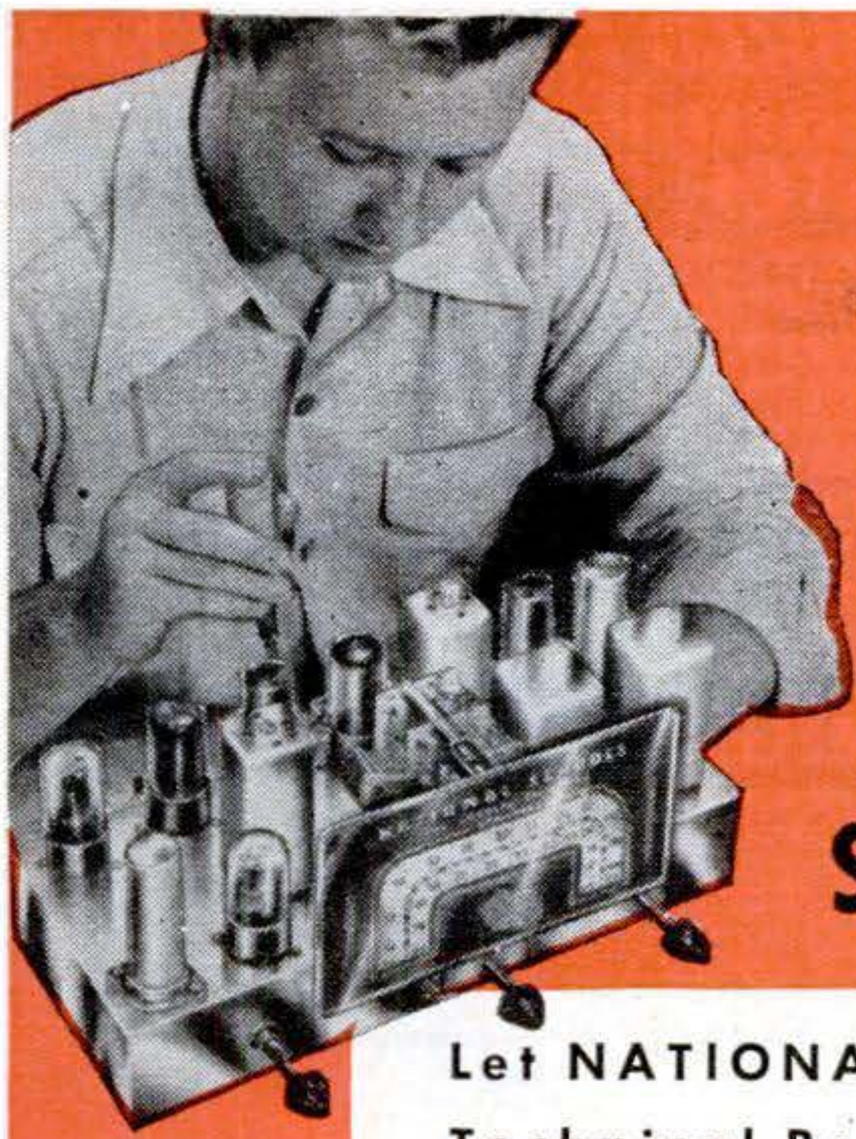

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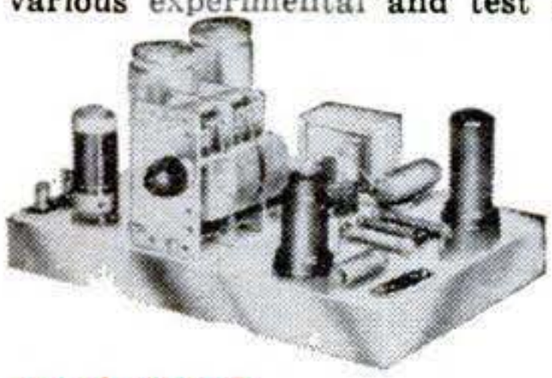

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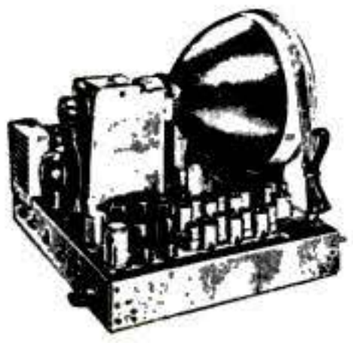

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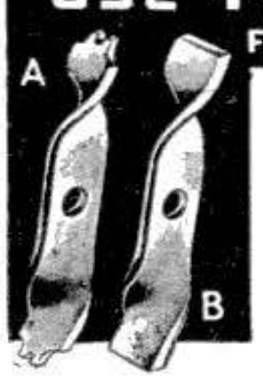

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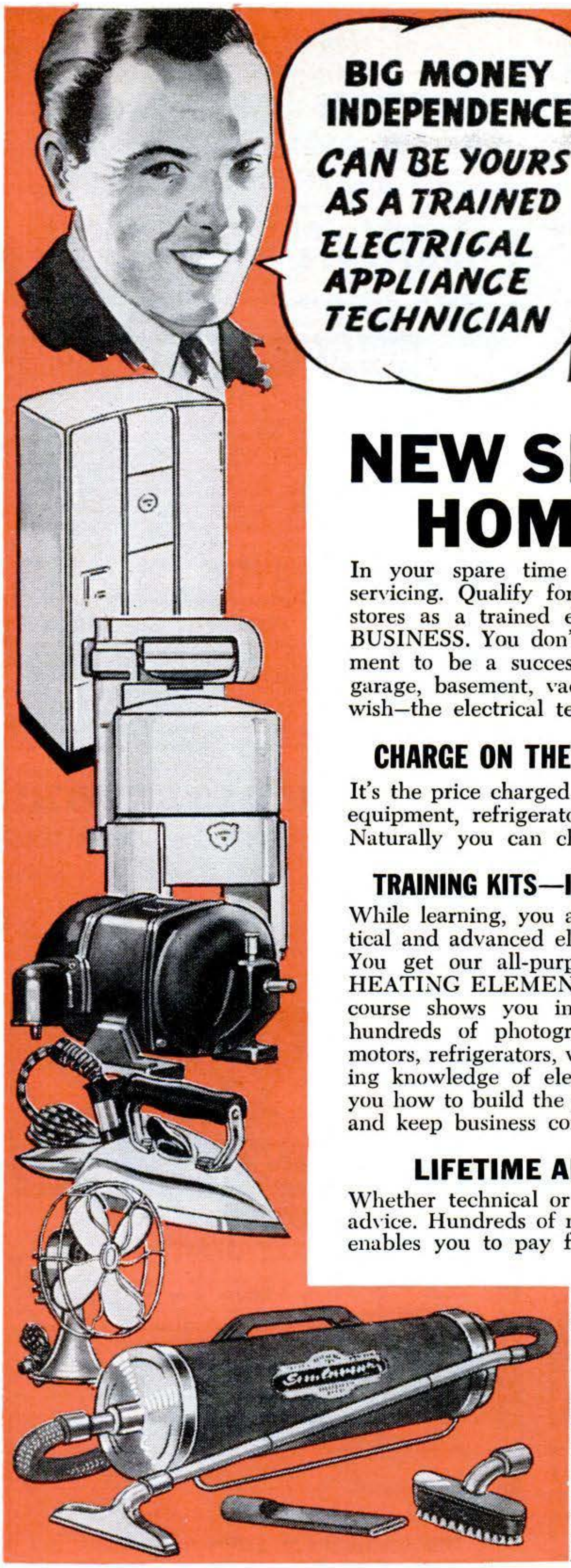

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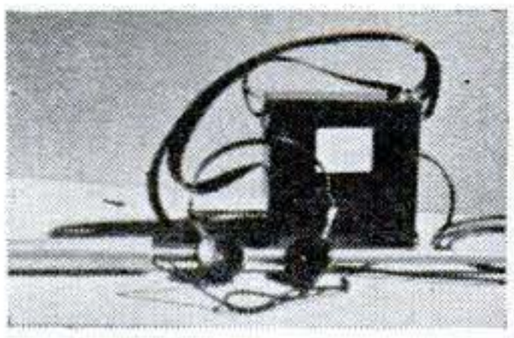

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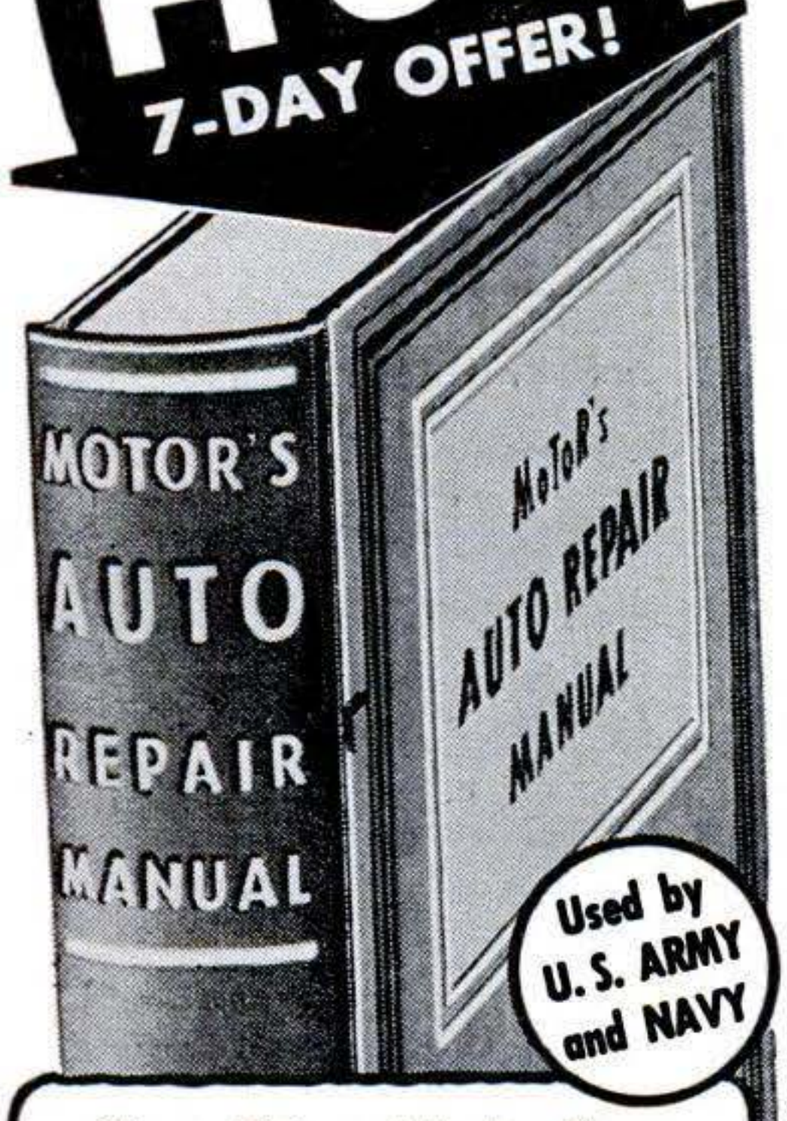

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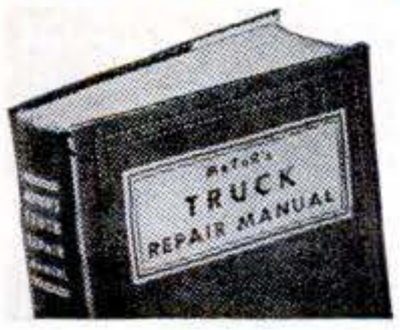

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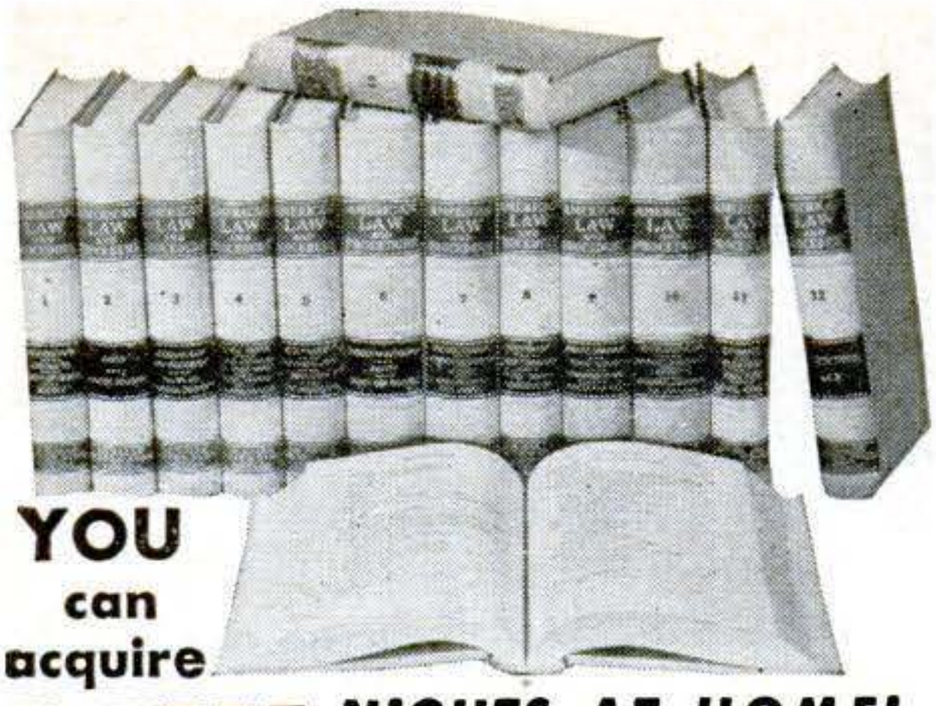

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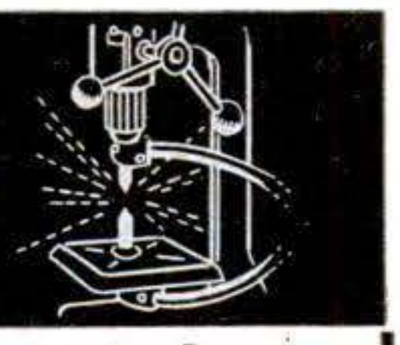

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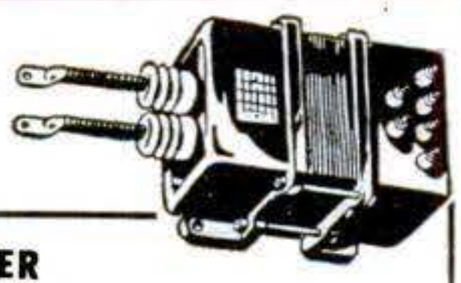

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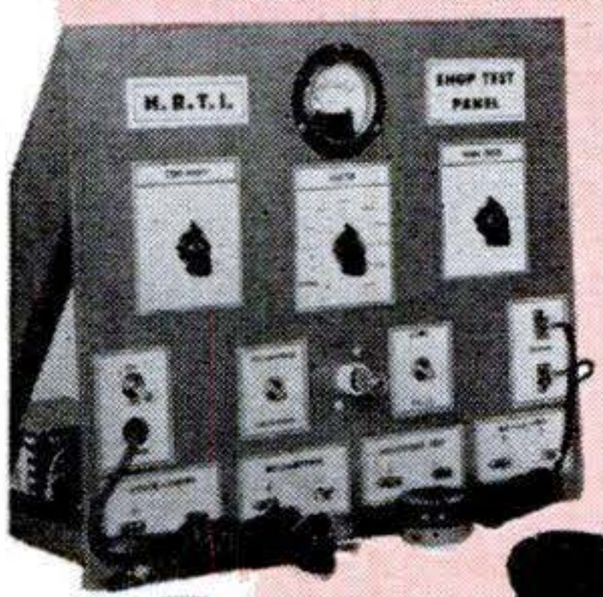

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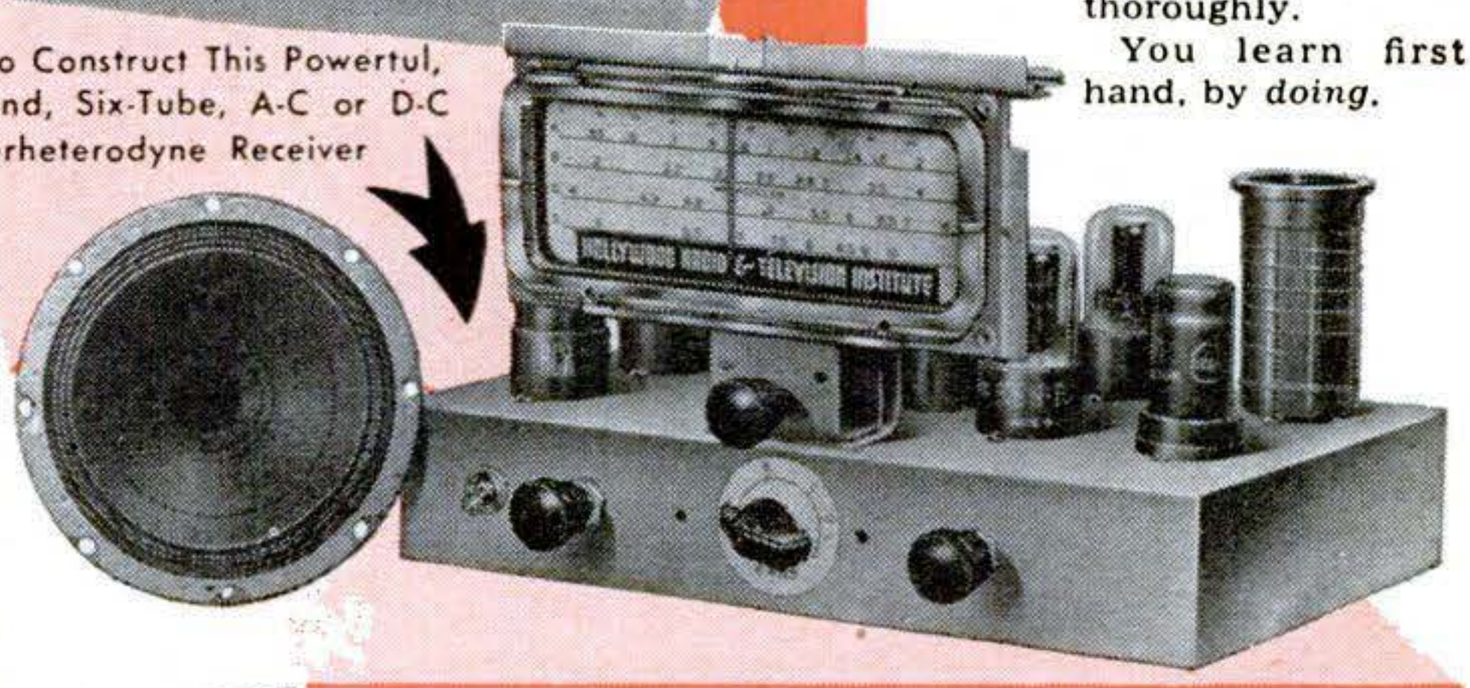

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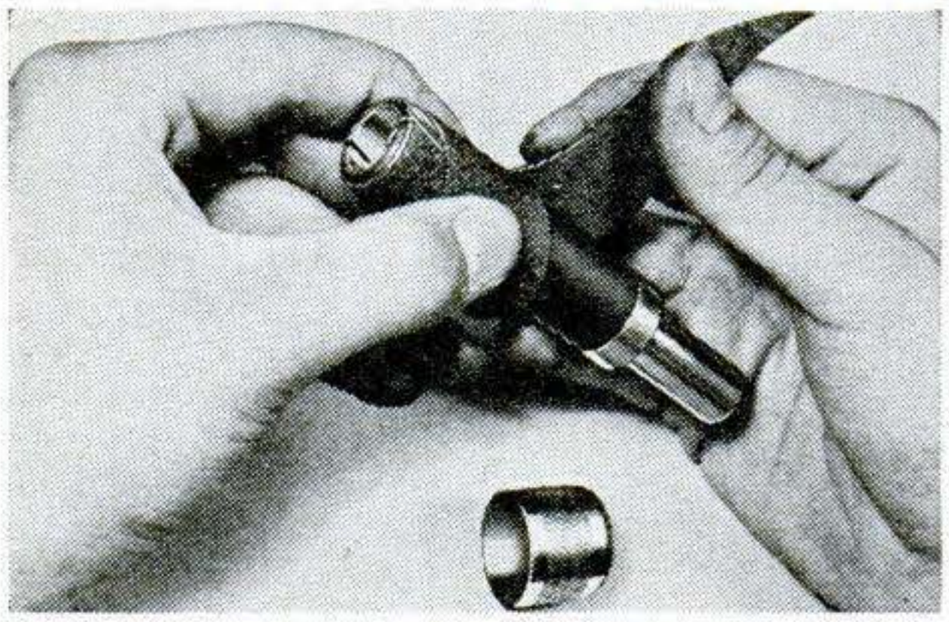

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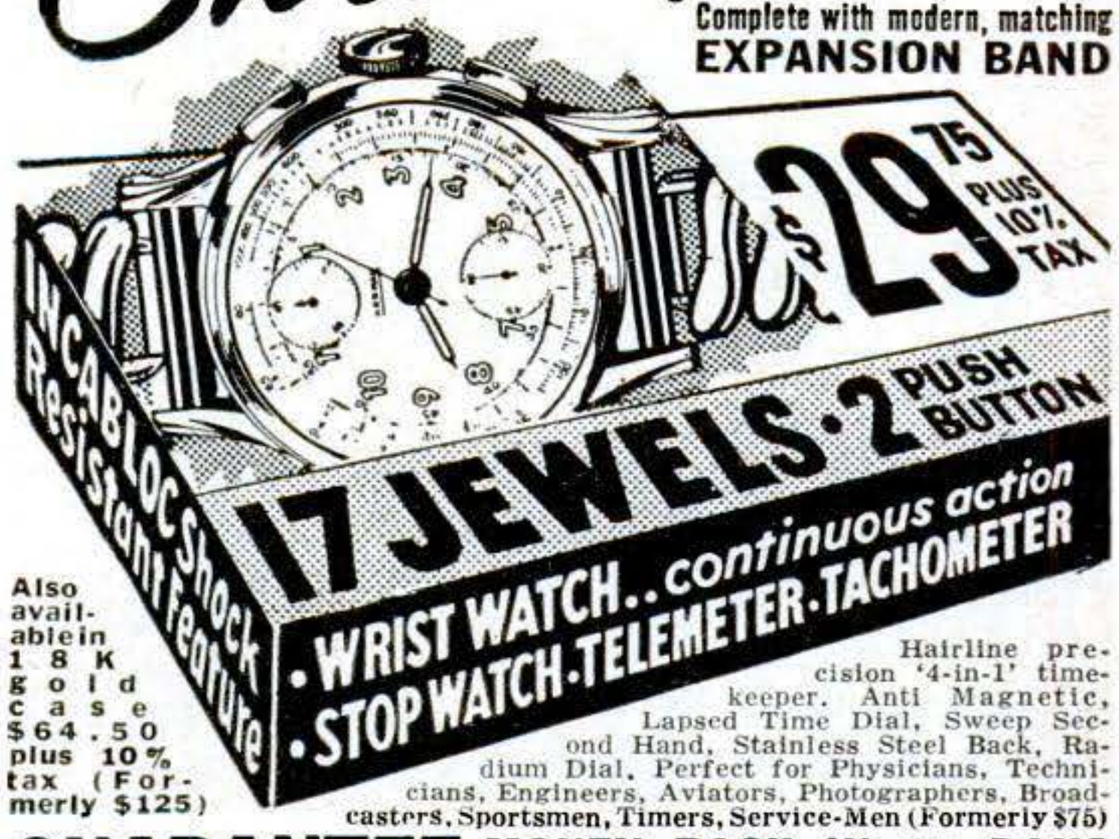

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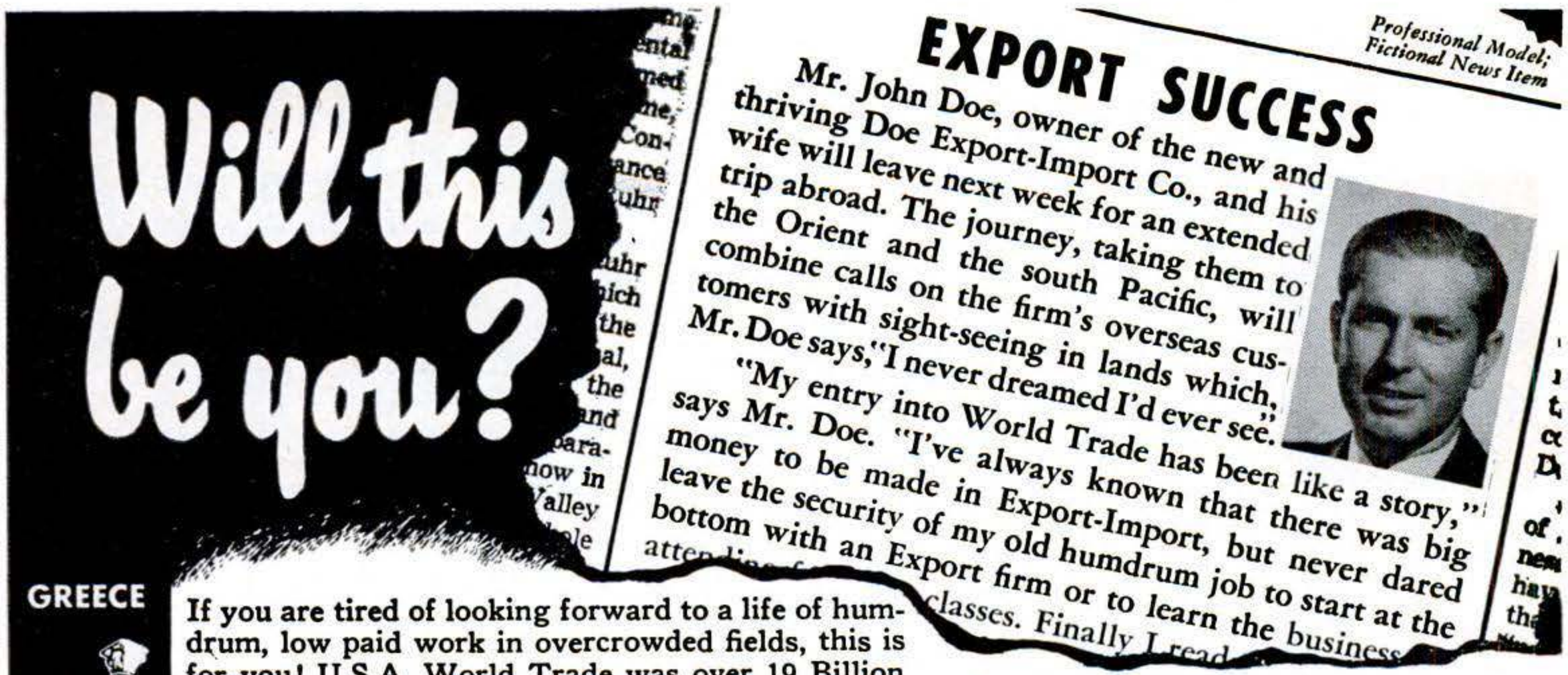

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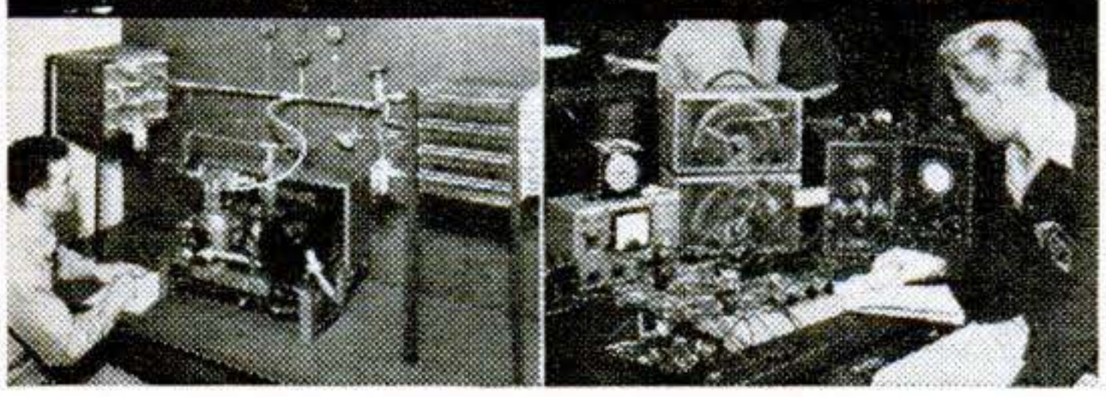

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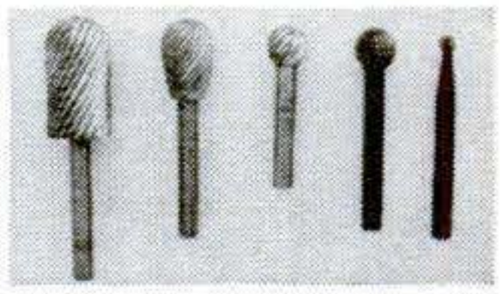

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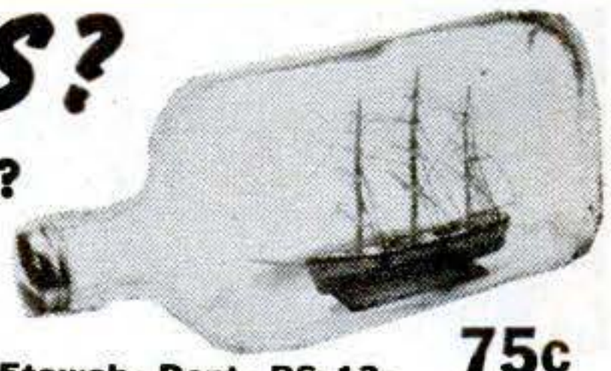

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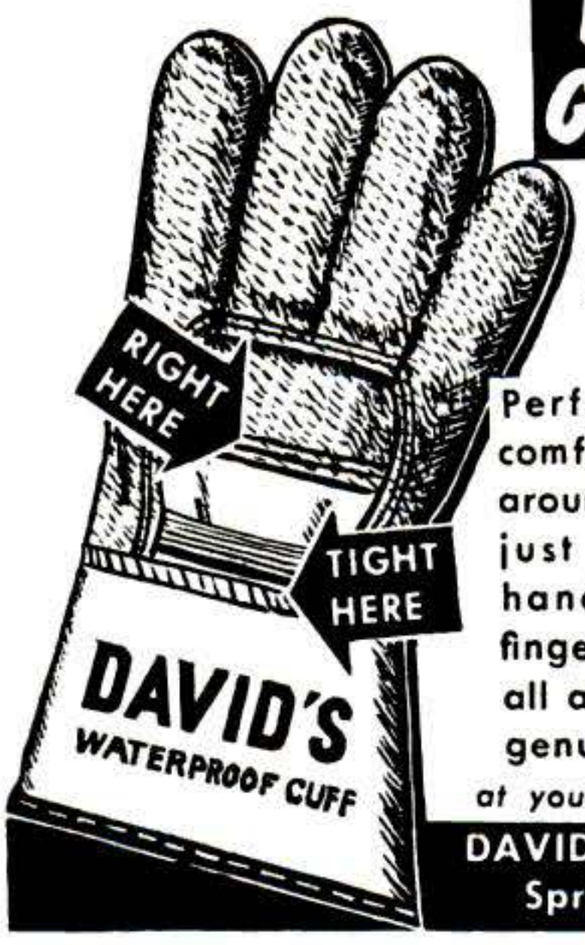

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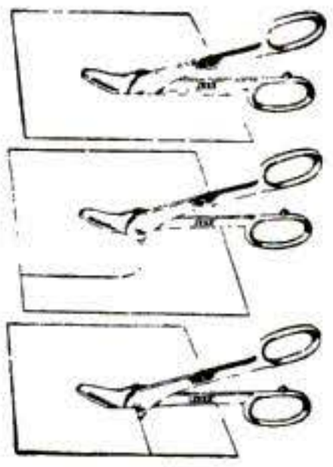

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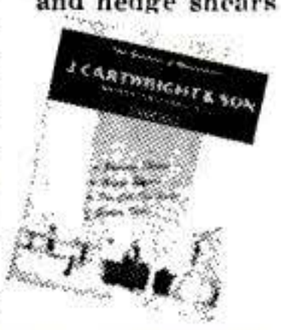

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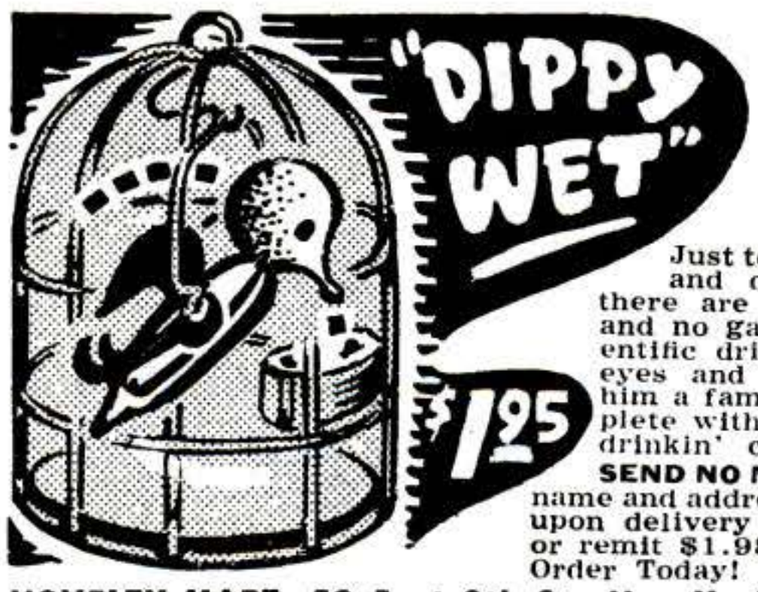

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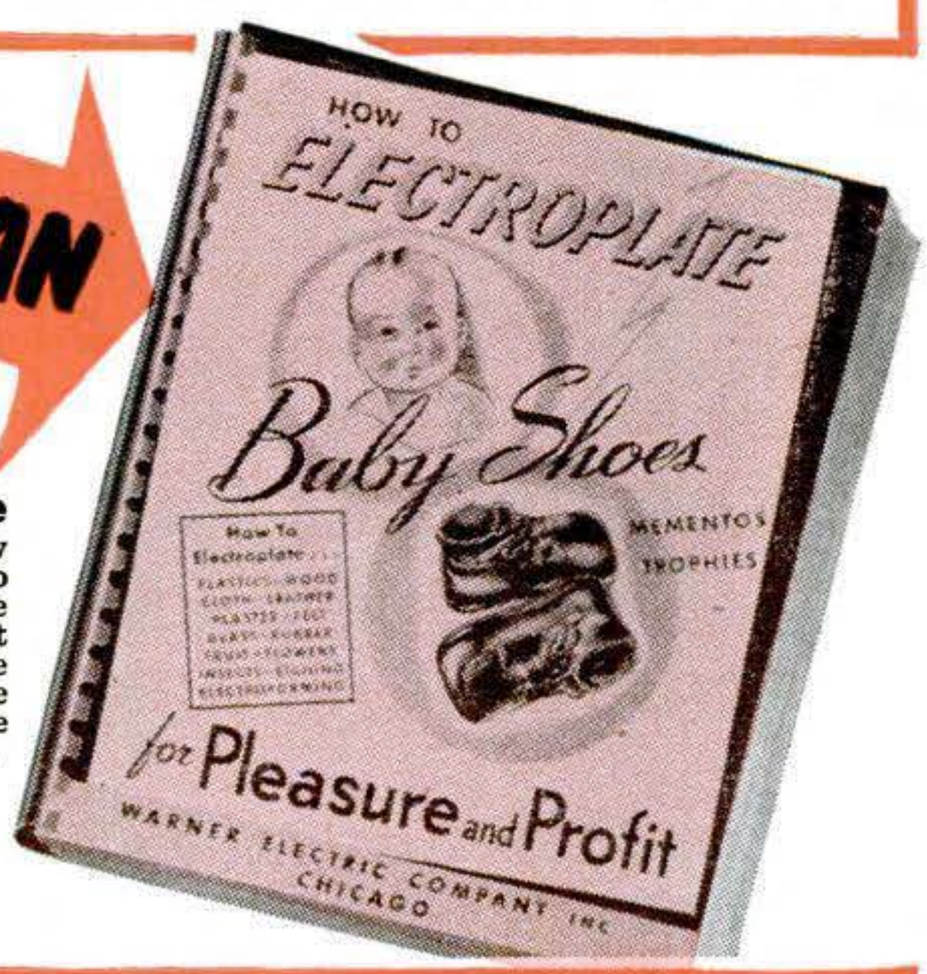

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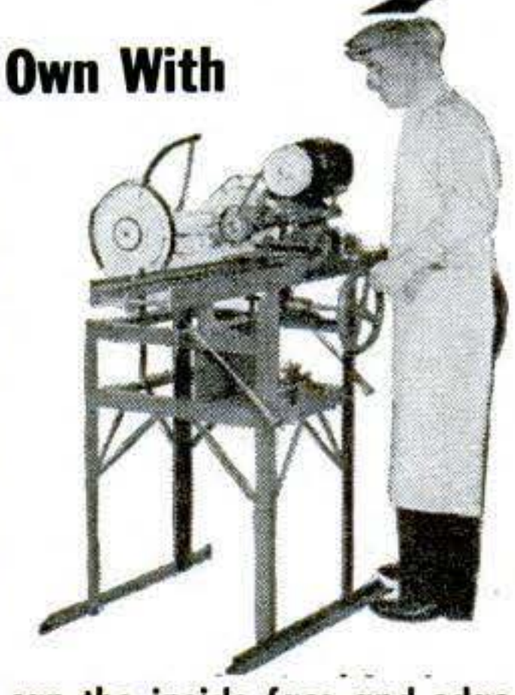

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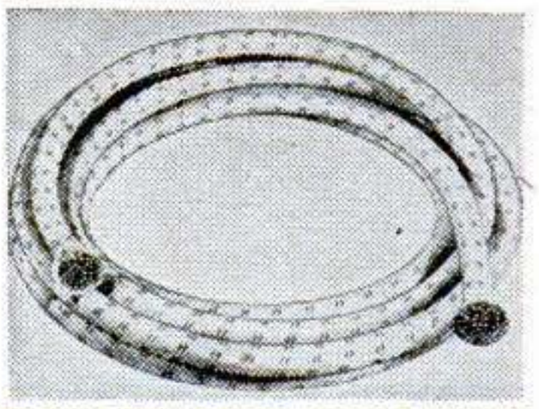

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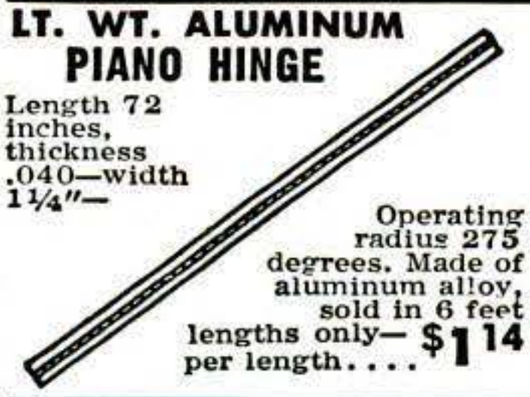

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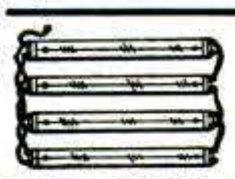

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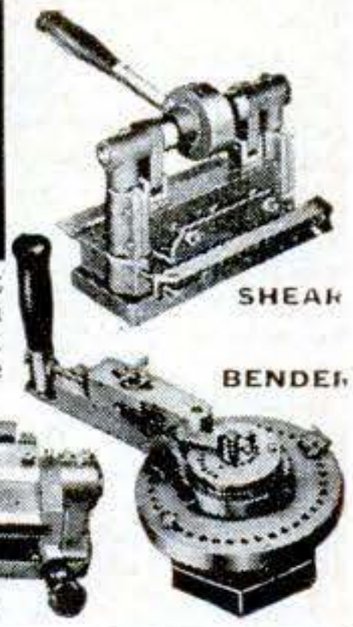

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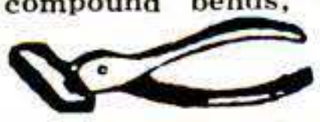

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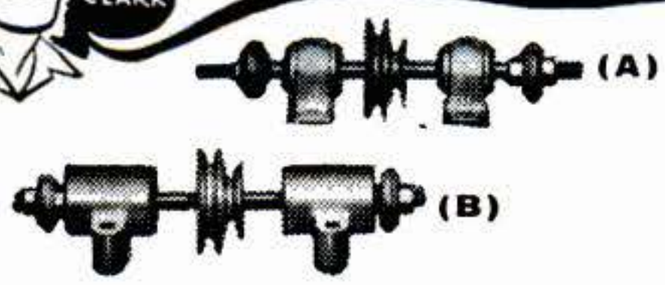

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50 ft.	100 ft.	250 ft.	500 ft.
$12.00	$20.00	$45.00	$85.00

4 conductor neoprene covered # 18 stranded tinned copper wire (two blacks & two whites). Run in parallel gives you #16 gauge. Lugs furnished for parallel run. Water & oil resistant. **(Stock #346)**

100 ft.	250 ft.	500 ft.	1320 ft. reel
$4.25	10.00	$19.00	$36.00

150 ft. reels, 3 wire #6 with 4, 60 amp Crouse & Hines connectors—2 male & 2 female. Perfect for welders, hay loaders, saws, electric ranges, etc. List price $190 per reel. **Stock #313. OUR PRICE** **$65.00**

JARVIS GRINDERS

2 HP, 60 cycle, 220-440 volt, 3450 RPM. Totally enclosed G.E. motor with 6 ft. flexible shaft. List price $285. **Stock #326.** Used, like new **$85.00**

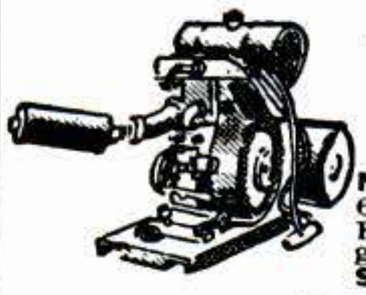
AS ABOVE with 1½ HP motor **Stock #330** **$75.00**

AS ABOVE with 1 HP motor **(Stock #331)** **$65.00**

Horns and Howlers

Motor driven. (not a vibrator). Heavy duty with great power and long life. Adjustable for high, medium or low tone. 110 volt AC current. Weather proof. For alarm or signal horn on boats, school yards, factories, etc. List price $47.00. **NEW. Stock #302. OUR PRICE** **$9.45**

AC ARMY LIGHT PLANTS

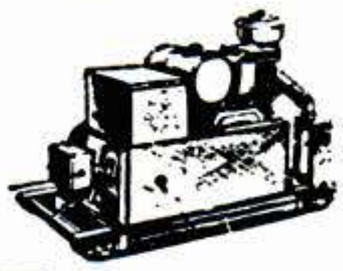


New 750 watt 110 volt, 60 cycle light plant with Briggs-Stratton model AP gas engine. **Stock #315.** **$145.00**

New 1000 watt 110 volt, 60 cycle light plant with Briggs-Stratton model BP gas engine. **Stock #316** **$175.00**

New 2500 watt 110 volt, 60 cycle light plant with Briggs-Stratton model Z 6 HP gas engine. **Stock #317** **$265.00**

Rebuilt 5000 watt 110 volt, 60 cy. light plant with automatic remote control. Powered by Jeep 4 cyl. gas engine. Rebuilt like new and guaranteed. **Stock #318** .... **$ 625.00**



7,500 watt, 110 volt AC light plant powered by VE-4 Waukesha 4 cyl. gas engine. Continental or Hollinsworth generator. Remote control starting with 100 ft. starting cable, and 100 ft. of 3 wire #6 cable. Complete switch board. Used, like new. **Stock #347** **$675.00**

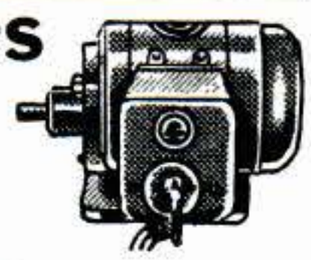
Add $65.00 for transformer to make plant 3 phase, 220 volt.

10,000 watt 110 and 220 volt, 60 cy. light plant with automatic remote control. Powered by Jeep 4 cyl. gas engine. Rebuilt like new and guaranteed. **Stock #319** **$900.00**

PORTABLE DC LIGHT PLANT

3000 watt 110 volt DC powered by new 6 HP Briggs-Stratton model ZZP gas engine. Rebuilt generator. Generator alone lists at $243.00. Has volt meter, rheostat, 4 female plugs, and ball bearing 2.75 x 10 rubber wheels. Guaranteed. **Stock #320** ..... only **$165.00**

GENERATORS



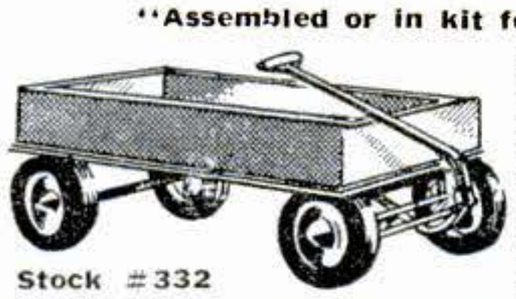
DC—3000 watt, 110 volt. Has voltmeter, rheostat & 4 female plugs. Lists at $343. **Stock #321. OUR PRICE.** **$60.00**

AC—750 watt 110 volt 60 cy. with voltmeter, rheostat, ¾" shaft. Dimensions: 9"H x 12"W x 13"L. Wt. 52 lbs. Shielded to prevent radio interference. Mfg. by Elcor. $125.00 value. **NEW. Stock #322. OUR PRICE** **$49.50**

DC—300 watt, 12 volt, 2900 RPM. Heavy duty, with current cut-out relay, high and low switch, 30 amp meter, charge and discharge. Mfg. for the Army by the Marathon Elect. Co. Can be used for boats, trucks, tractors, light plant, wind mills, etc. ¾ HP gas or ½ HP electric motor will drive it. Sleeve bearings. Dimensions: 11½"L x 10½"W x 7"H. Base holes 4¾" long, 6" wide. Can be bought less shaft and base to be used direct mounted to Briggs-Stratton 1 HP engine. **NEW. Stock #323** **$7.00**

Complete with base, shaft and bearing. **NEW. Stock #324** **$15.95**

HALF TON WAGON
"Assembled or in kit form"



Stock #332

Heavy duty wagon with plate aluminum body. 24" x 42". Sides 51½" high. ⅝" steel axle with ball bearing wheels and Goodrich Silvertown puncture proof balloon tires, 2¾ wide by 10" in diameter. Has heavy steel under-frame. Will carry 1,000 lb. load. Easy wheeling. Wide tread tires for mud, snow, gravel, etc. Will not mar floors. Ideal for newsboys, farms, grocers, parts dept, mail dept, factories, etc. Approx. weight 80 lbs. Nothing like it now on the market.

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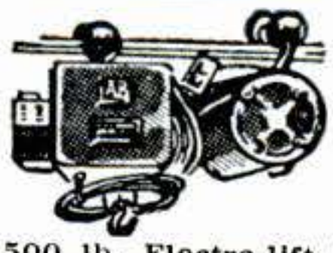
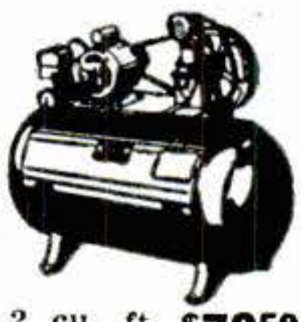


Electro-lift HOIST

500 lb. Electro-lift Hoist, 17 ft. of cable—up and down button and trolley, 3 phase, 220 or 440 volt, 60 cycle. Used, in A-1 shape. List price $185.00. **Stock #301. OUR PRICE** **$90.00**

Specify 220 or 440 volt

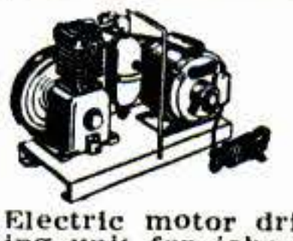
Automatic AIR COMPRESSOR



Complete, piston type with 10 gal. tank, ⅓ HP capacitor type, AC. 110-220 volt 60 cycle motor. V-belt drive. Will develop 75 lb. pressure—approx. 2 cu. ft. Brand new. **Stock #340** ..... Only **$79.50**

Assemble yourself and save $10. ABOVE tank with legs and saddle **$11.95**

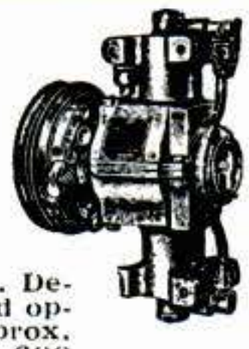
AS ABOVE—½ HP motor, 2 cyl. Westinghouse compressor. 3 c.f.m. at 75 lbs. **$109.50**



Portable AIR COMPRESSOR

Electric motor driven, portable spray painting unit for jobs requiring a larger quantity of material. Piston type, single cyl. air compressor has 2" bore by 1¾" stroke. 2.86 CFM. Max. working pressure 40 lbs. Mounted on base. Equipped with safety valve & drain cock. ⅓ HP capacitor type motor, 110 volt AC, with cord and plug. 20 ft. air hose and fittings. Ship. wt. 45 lbs. Brand new. **Stock #348** ..... only **$42.50**

Westinghouse AIR COMPRESSOR



Brand new piston type, 2 cyl. compressor with automatic clutch. Westinghouse model T-1. Can be run off power takeoff or ½ HP motor. Delivers "oil free" air. Suggested operating pressure, 75 P.S.I. Approx. displacement 3.27 c.f.m. at 600 RPM. Ideal for spraying, industrial work, tire inflation, painting, etc. Approximate weight 23 lbs. **Stock #345** .... Only **$22.50**

KELLOG AIR COMPRESSOR

Kellog Model 241 air compressor. Piston type with 2" x 1¾" bore. Capacity of 2.8 CFM at 100 lbs. V-belt drive. ¾" shaft. Can be run with ⅓ or ½ HP motor. Delivers oil free air. Max. recommended working pressure 150 lbs. **Stock #349 NEW** ..... only **$14.95**

PORTABLE BUZZ SAW

Powered by 6½ HP Briggs & Stratton air cooled gas engine. Adjustable hinge, requires no clutch. 28" blade, will take up to 12" hardwood. 1⅜" ball bearing mandrel. Has power take-off. Complete unit mounted on two wheels with 400 x 8 pneumatic tires. Has tow bar for trailing. Wt. approx. 400 lbs. Sold complete or less blade, engine or wheels. Make $25 to $50 a day sawing wood with this sturdy unit. **Write for free Circular. Stock #350.**

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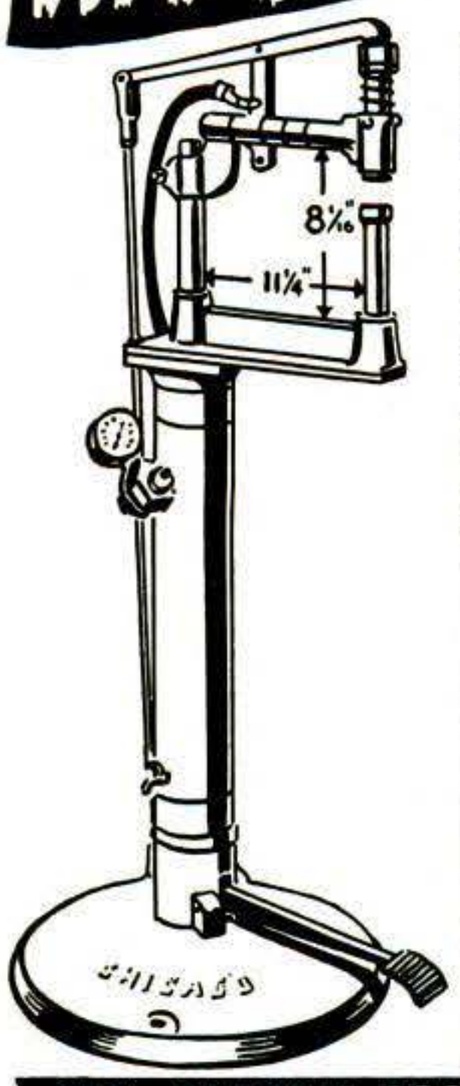

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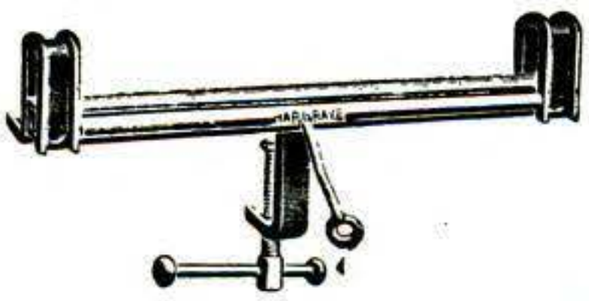

Clamps on any board or bench

Constructed for long satisfactory service, this Vise holds the saw between a strong steel channel section and eccentric rod. Fibre insert resists oil and grease, is securely riveted to channel section, affords double grip on saw, eliminating chatter. Standard saw set can be used with this vise. Filing space 10½" long.

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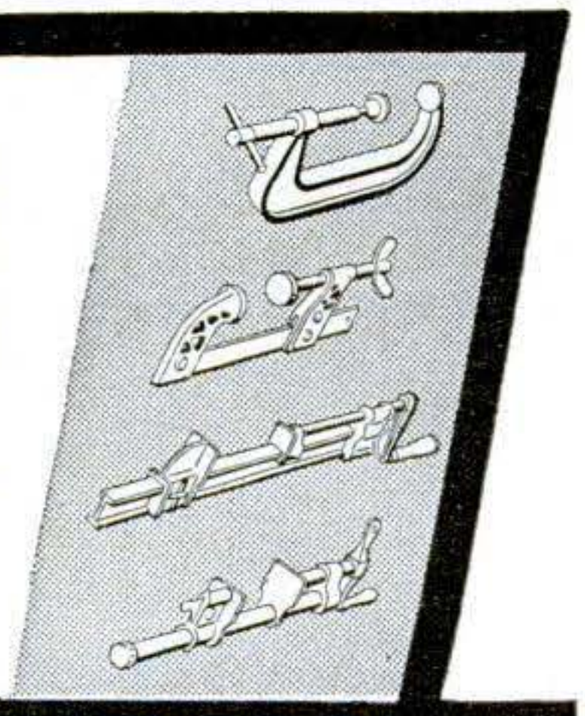

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N. River Oarlock	4"	5"	2.40	3.25	4.00 Per Pair
Bow Handle	5"	1¾"	.80	1.25	1.45 Each
Rear Handle	5¼"	1½"	.95	1.75	2.15 Per Pair
Chock	3¾"	1"	.95	1.75	2.15 Per Pair
Cleat	5"	1¼"	.60	.95	1.15 Each
Eye Bolt (stem 3/8"x3", ID 7/8")			.60	.80	1.00 Each
Anchor Pulley	6"	1¾"	1.40 each (aluminum, self-locking)		

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Accurate and practical, at a price you can afford. Polished aluminum case is 5¾" wide x 5 3/16" high. Requires only ½" hole through dash. Easy-to-read dial is full 3" diameter. Simply installed. Two models: 1 to 35 m.p.h.—**$10.95** and 10 to 50 m.p.h.—**$12.95** postpaid in USA, complete with all connections. A guaranteed instrument. See your dealer or order direct.

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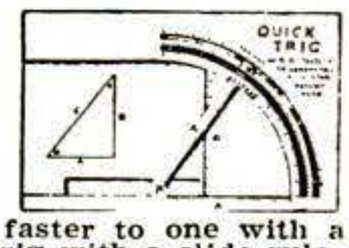

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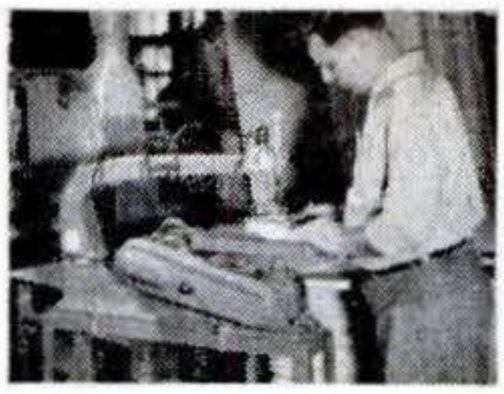

Many a business saves time and cuts costs, by using a Delta-Milwaukee Scroll Saw.

A Delta-Milwaukee Scroll Saw is first choice of hobbyists who know the deep satisfaction that comes from using quality tools.

DELTA MILWAUKEE®

Get *any speed* you need . . . from 650 to 1750 cutting strokes per minute . . . with a DELTA-MILWAUKEE® Variable-Speed 24" Scroll Saw

Preferred by those who know fine tools:

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—and others!

Cuts wood, light metals, plastics, hard rubber, asbestos, bone, hard leather, etc.

Convenient ball crank helps you pick the exact speed you require: High speed for fine work. Low speed for heavy work. **Any** speed in between.

That's an advantage the Delta-Milwaukee Variable-Speed Scroll Saw provides—one that is missing in machines with a limited speed range that is too slow for some materials and too fast for others.

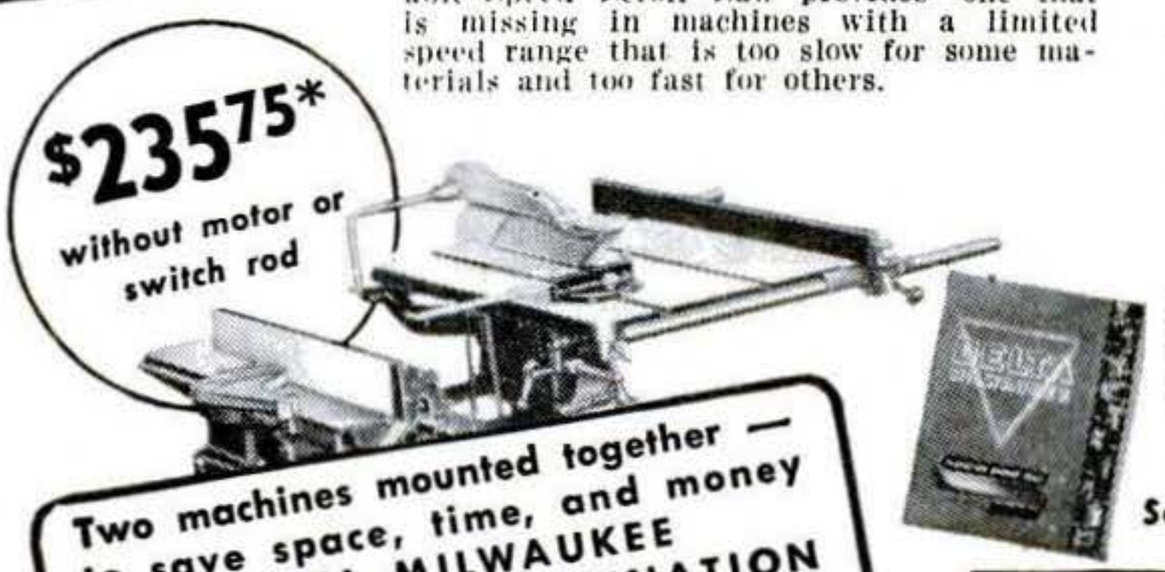
There are other reasons why this quality scroll saw is so well known for accuracy, speed, and long life. These are just a few:

- Timken tapered-roller bearings are automatically lubricated from splash system in crankcase.
- Table tilts to right and left—and to front, for side-wise cutting as well as straight cutting.
- Spring hold-down tilts with table. It is effective on bevel cuts as well as on straight cuts.
- Continuous-flow air pump drives directly from crankshaft independent of blade, thus eliminates a source of blade breakage.

Ask your nearby Delta distributor for the whole story on the Delta-Milwaukee Variable Speed-Scroll Saw. And have him show you the **complete line** of dependable, low-cost Delta-Milwaukee tools that he has on display.

*Prices subject to change without notice

You can cut work up to 1¾" thick. Distance to the overarm is 24" — big capacity for all kinds of jobs.

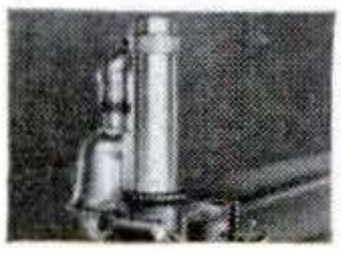


Two machines mounted together — to save space, time, and money

DELTA-MILWAUKEE SAW-JOINTER COMBINATION

Circular saw and jointer mounted on one steel stand and driven by same motor. Both may be operated singly or together. 10" saw blade cuts 3¼" stock. Rips to center of 50" panel. Jointer surfaces boards 6" wide; cuts rabbets ½" deep. Both tools have lubricated-for-life ball bearings. See this machine at your Delta distributor.

Universal chuck will take jeweler's blades, pin blades, saber blades, sanding drums, and round-shank files up to ¼" dia. shank, without extra attachments.



You can adjust tension spring over saw blade to suit type of blade used. Graduations on tube permit accurate settings.

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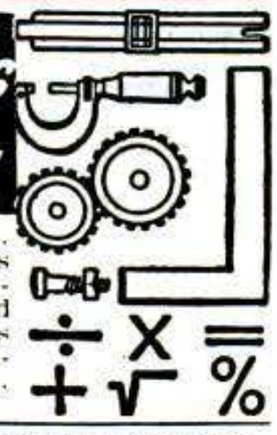

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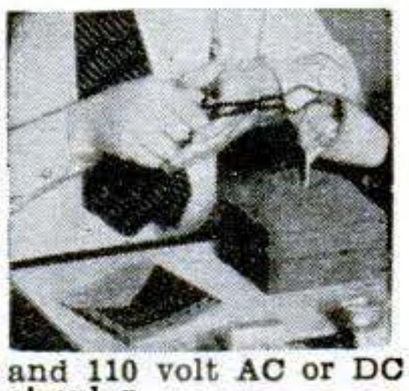

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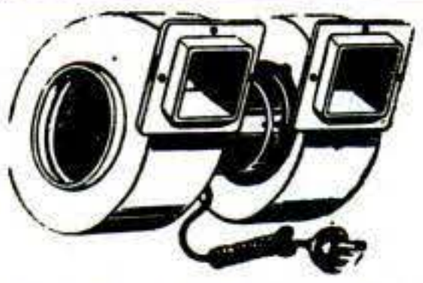

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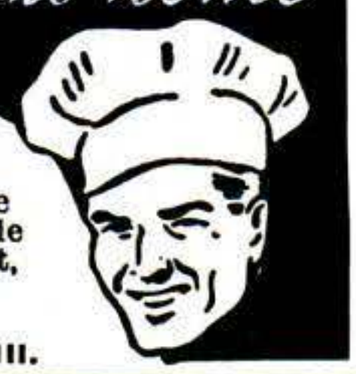

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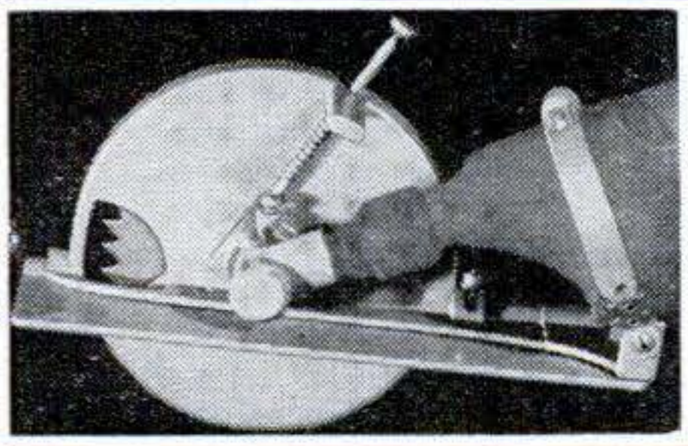

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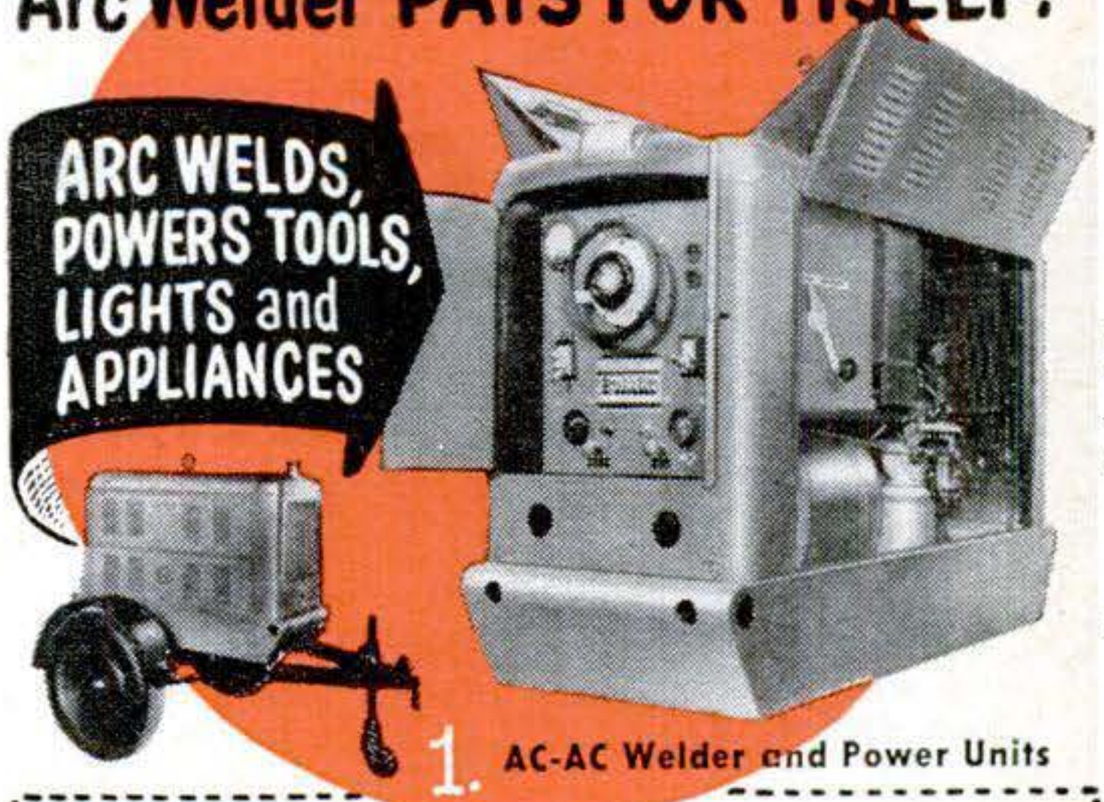

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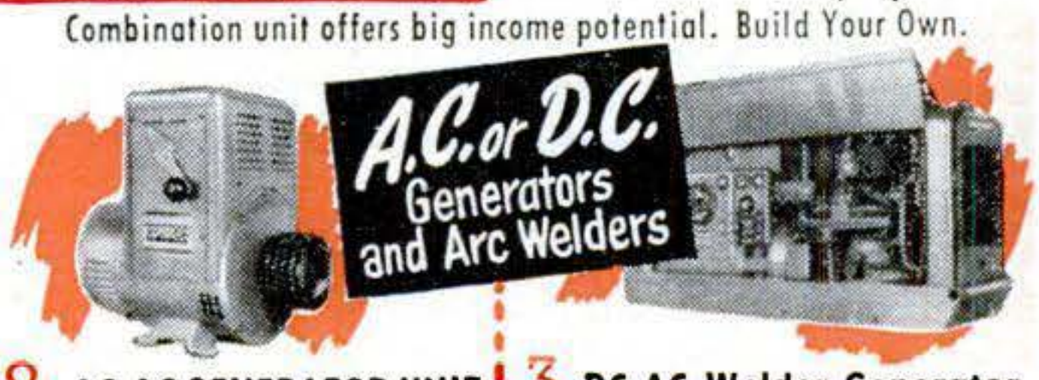

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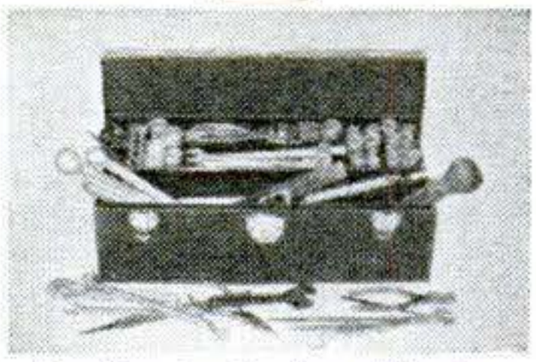

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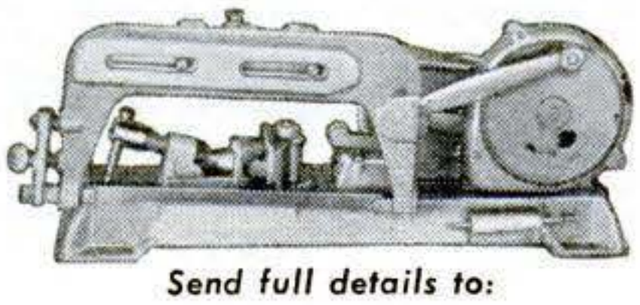

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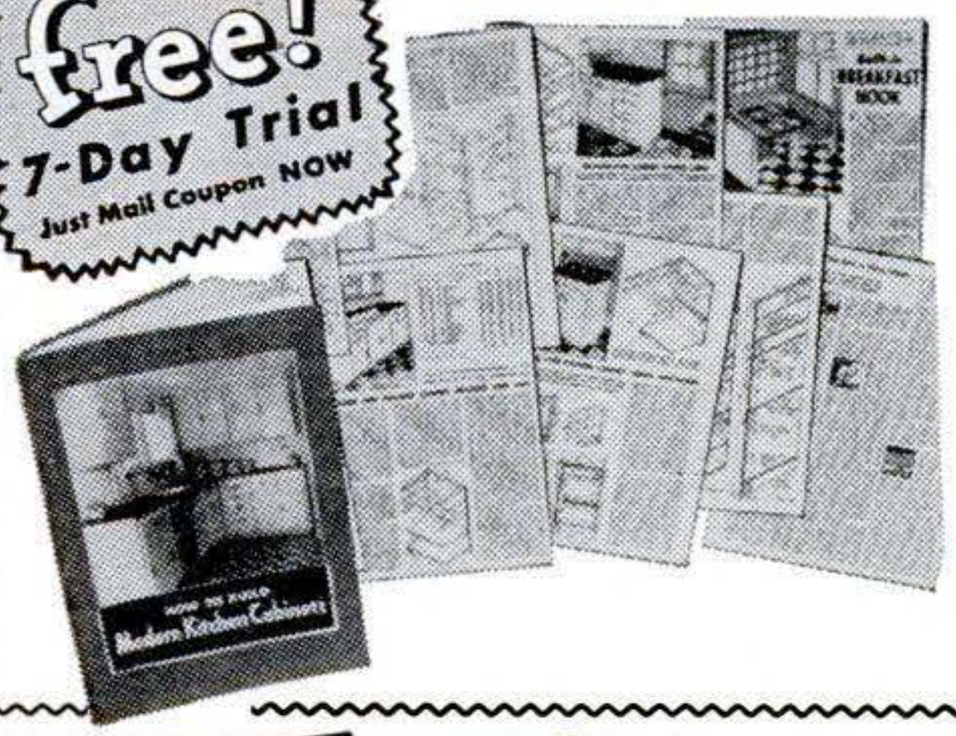

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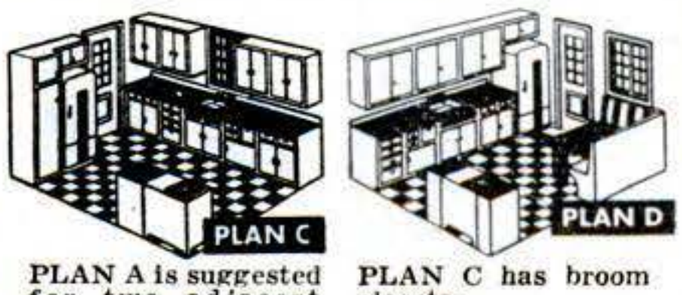

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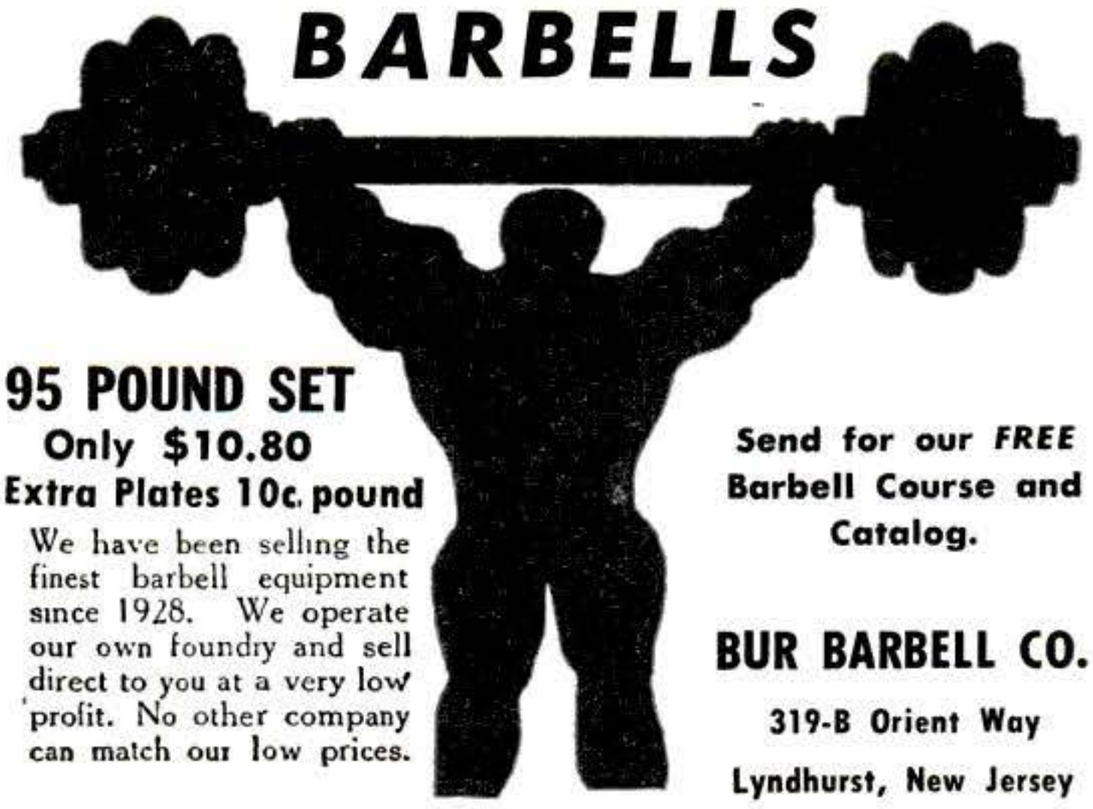

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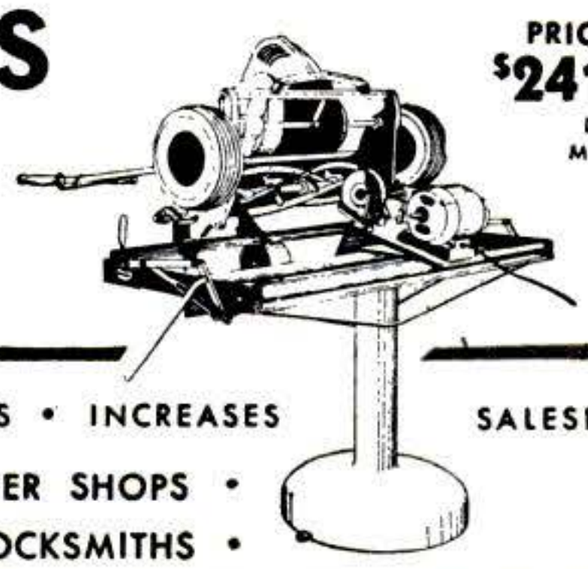

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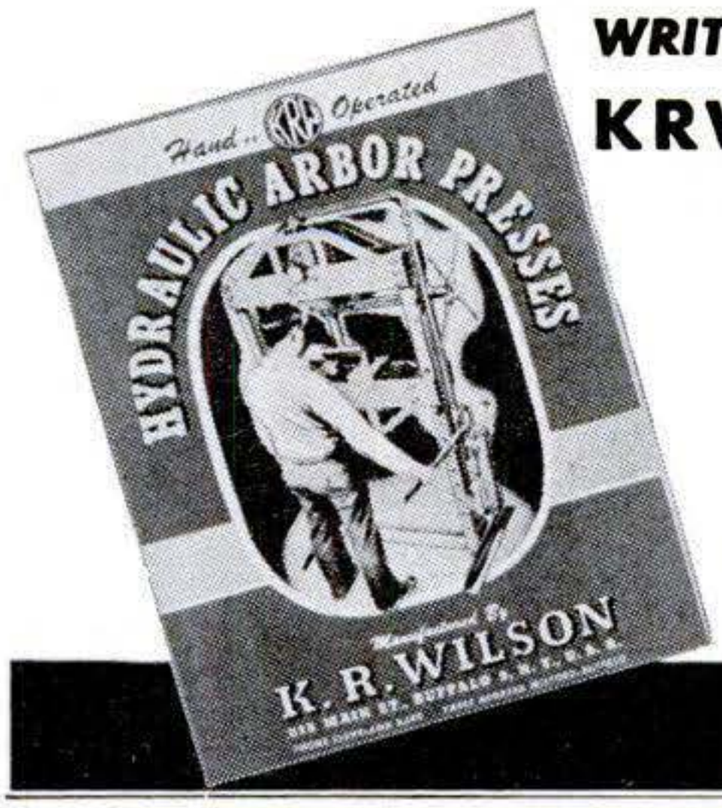

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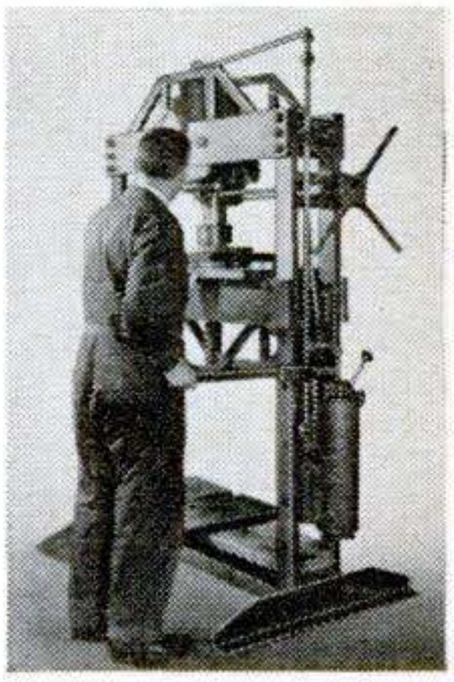

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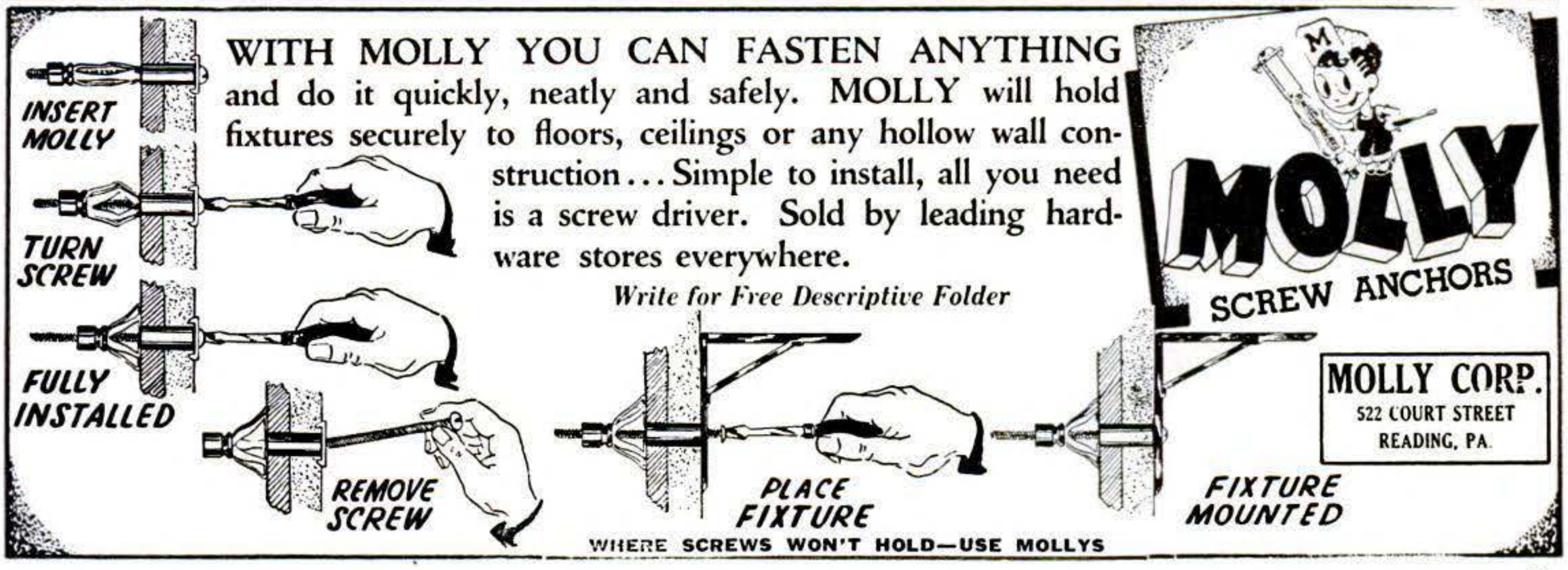

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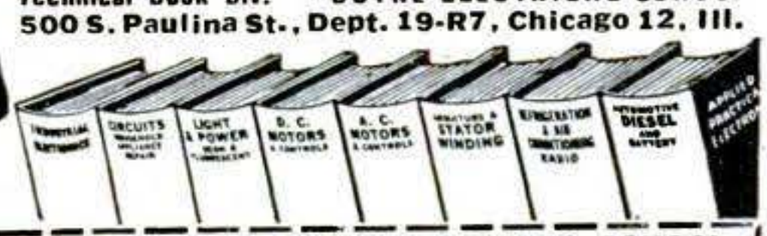

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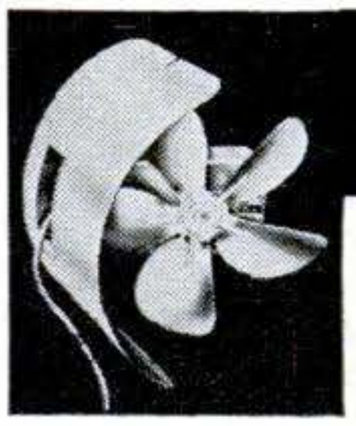

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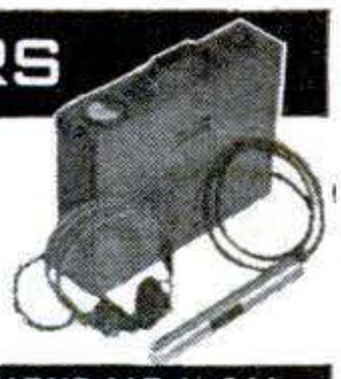

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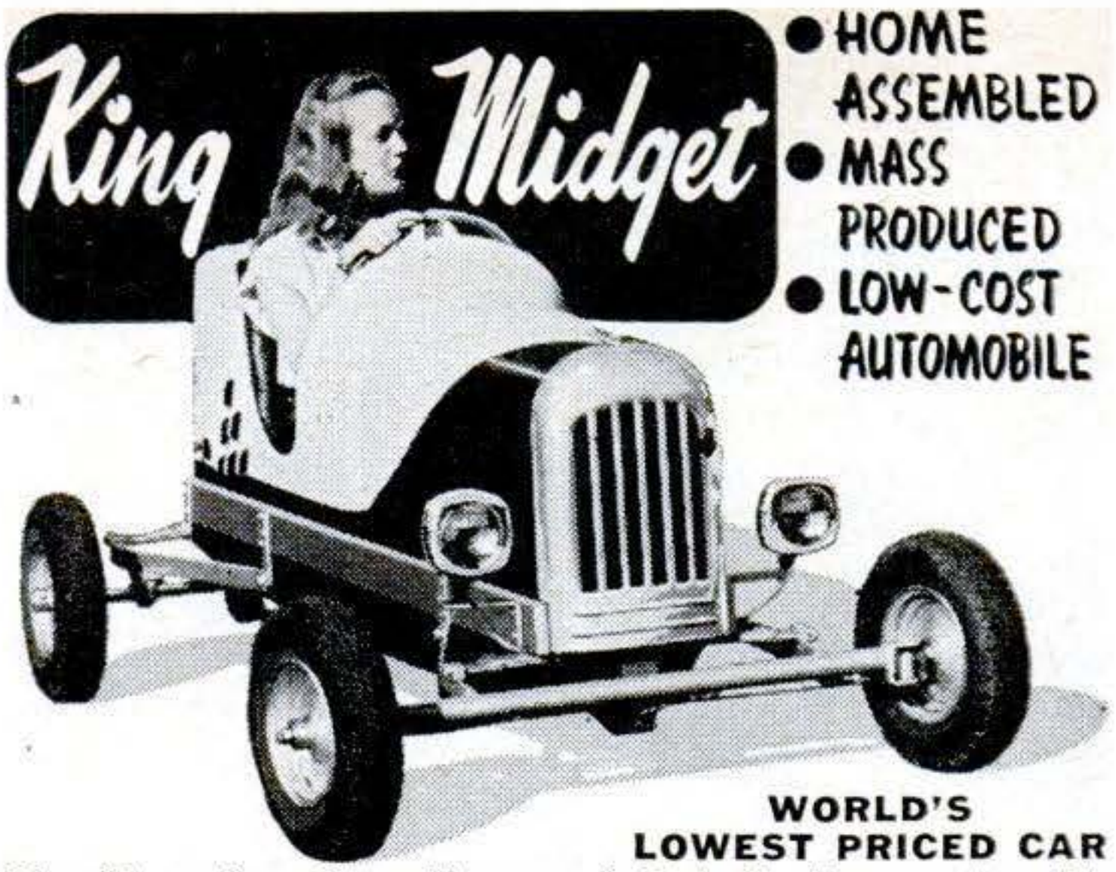

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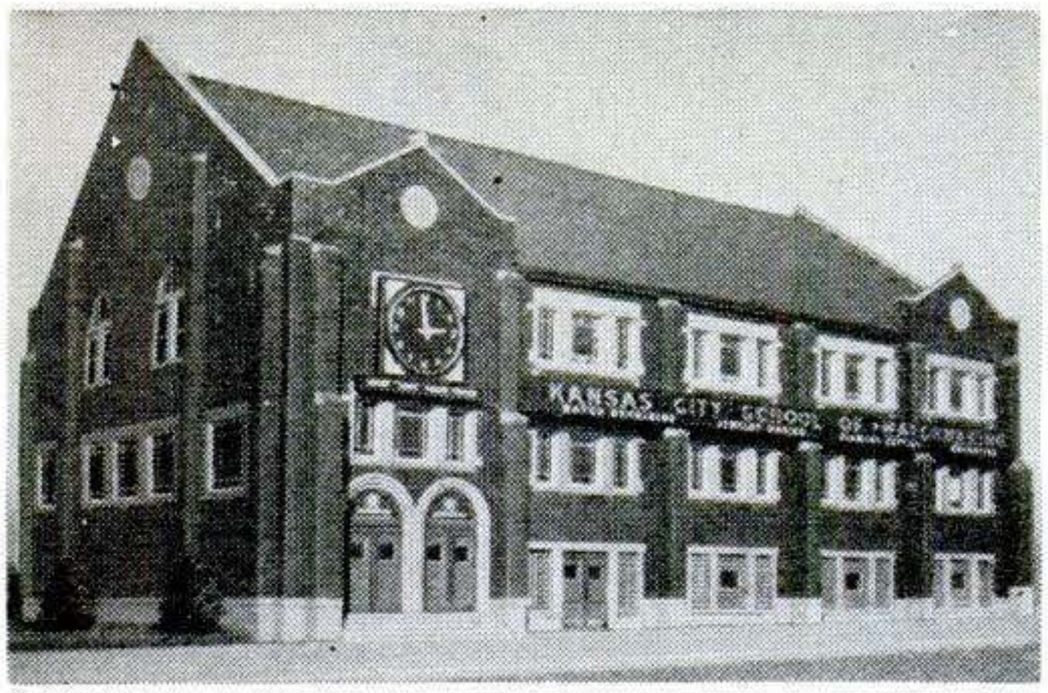

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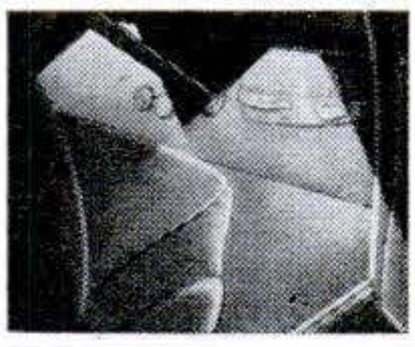

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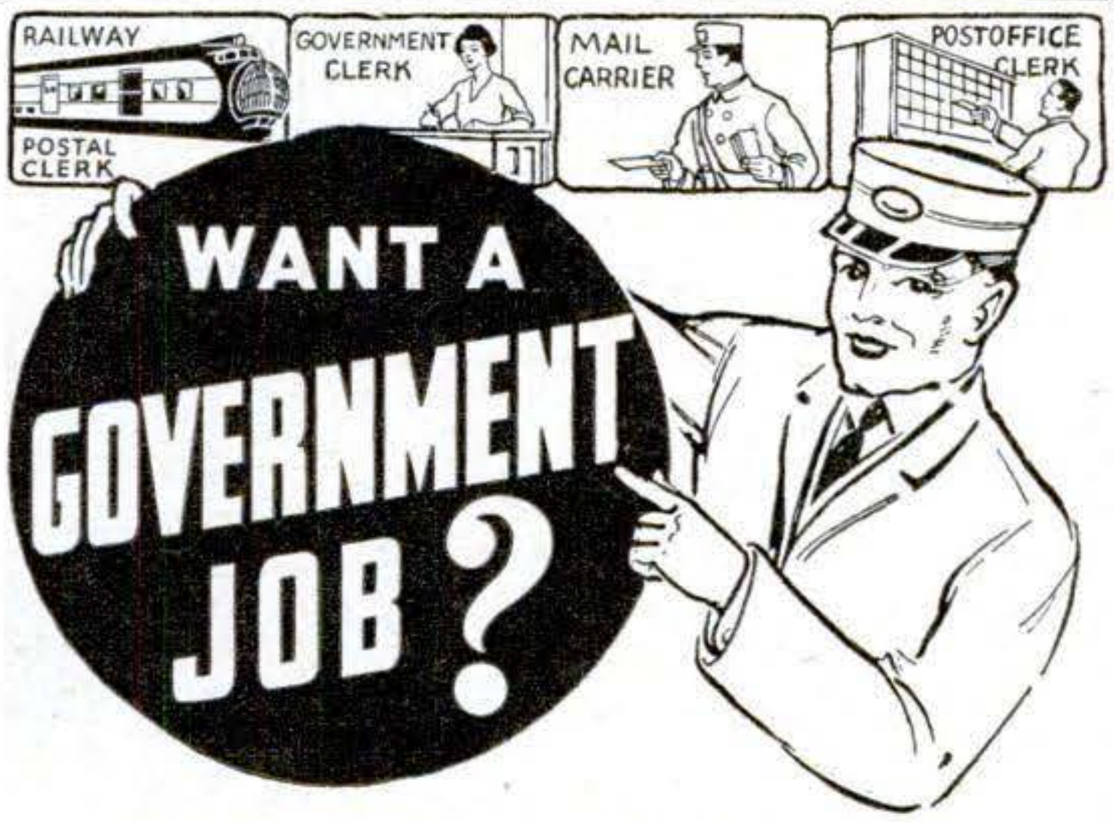

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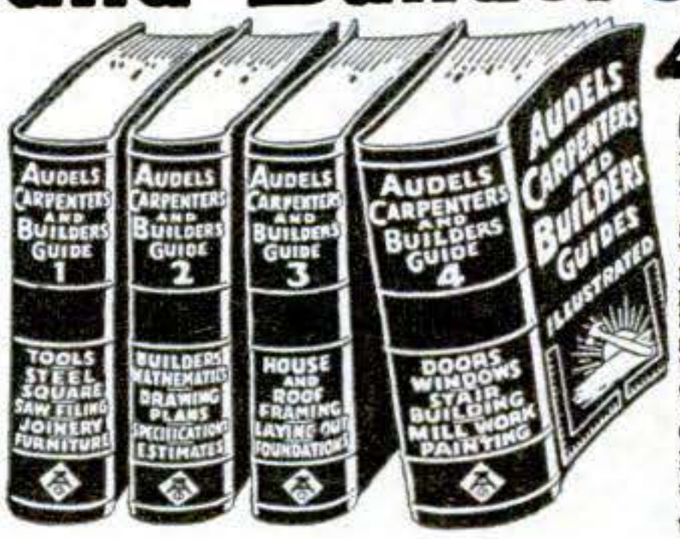

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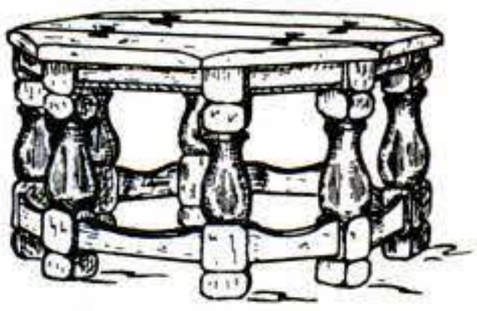

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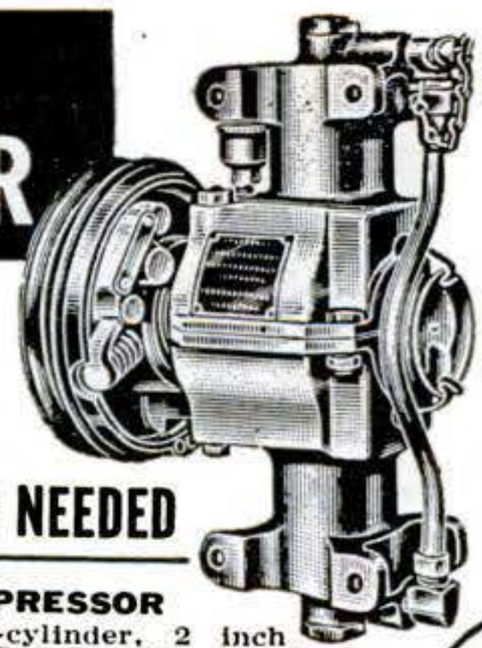

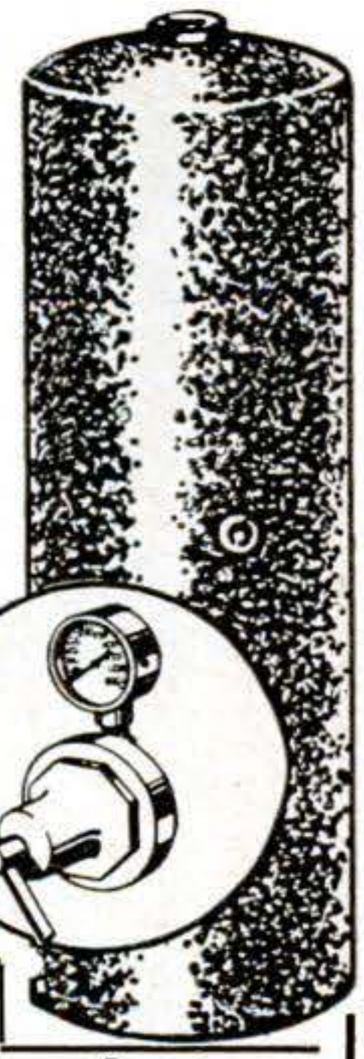

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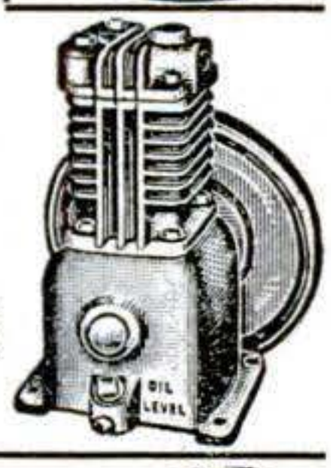

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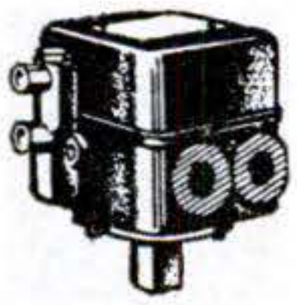

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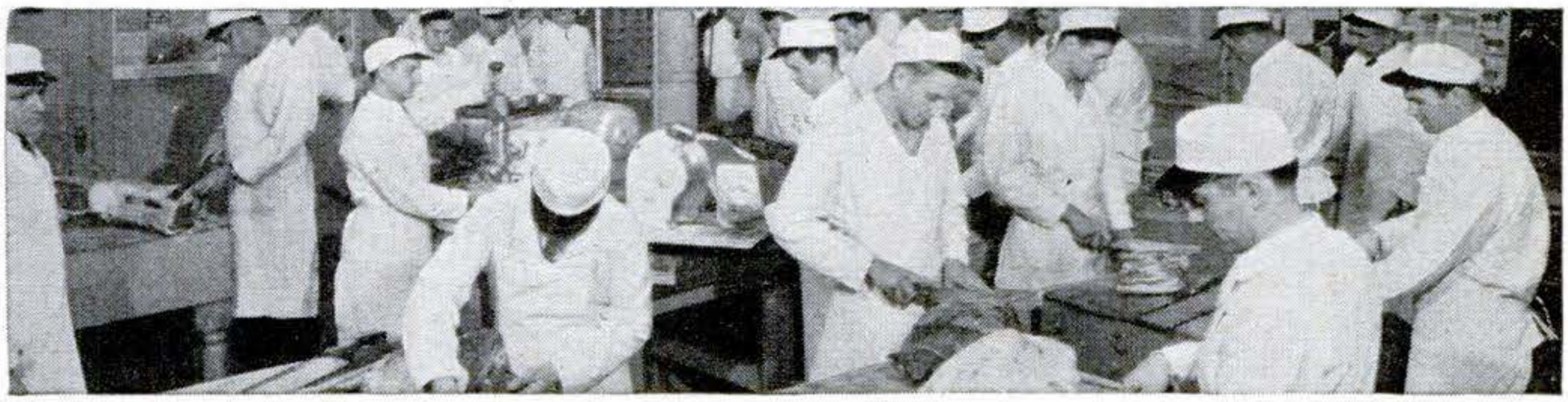

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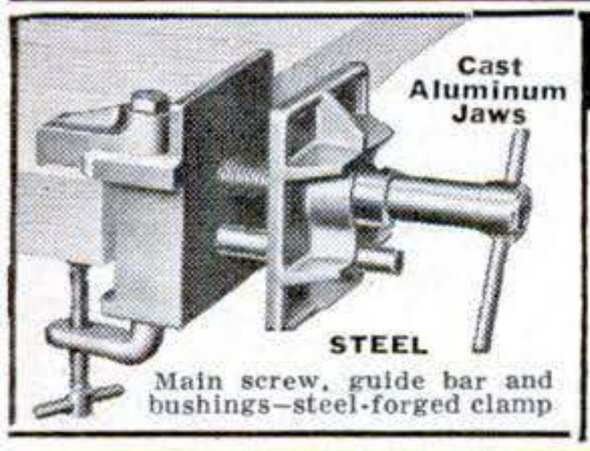

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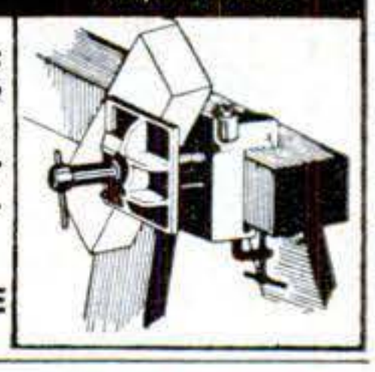

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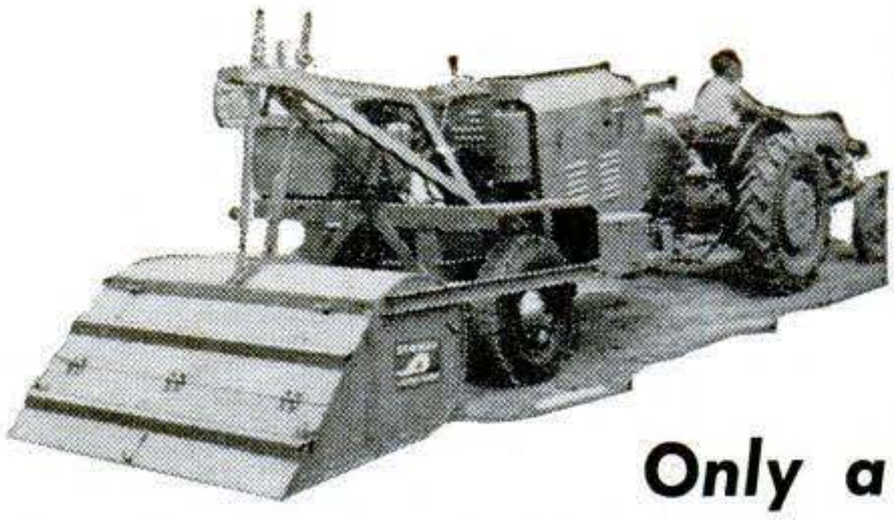

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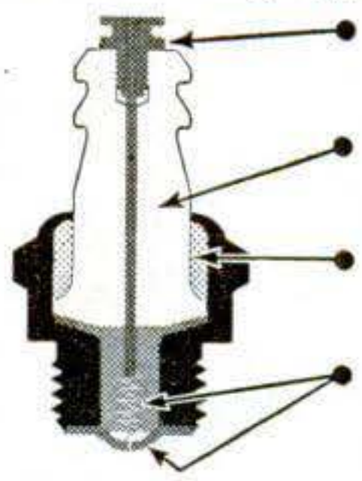

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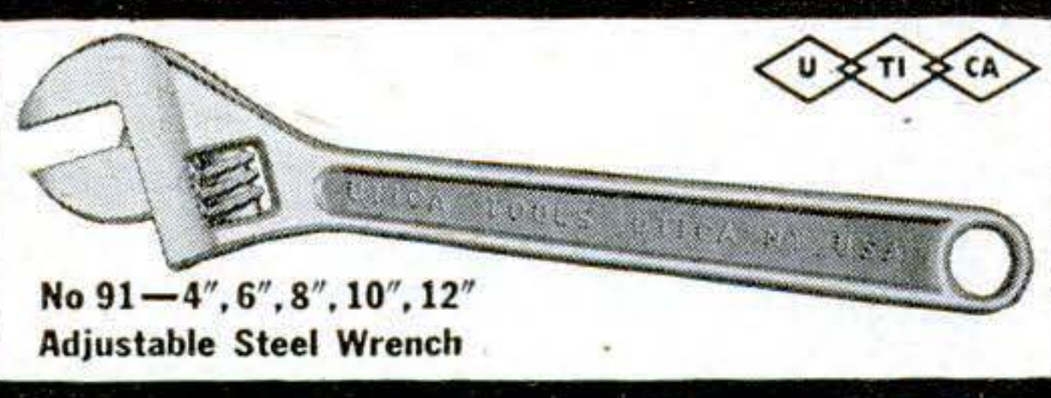

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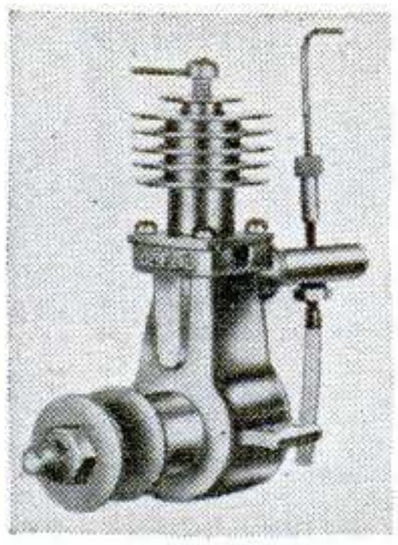

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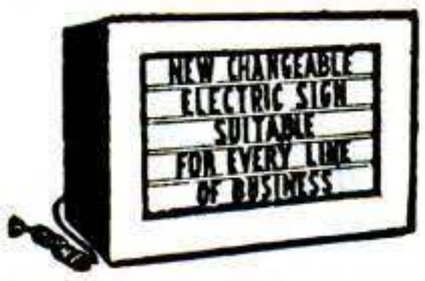

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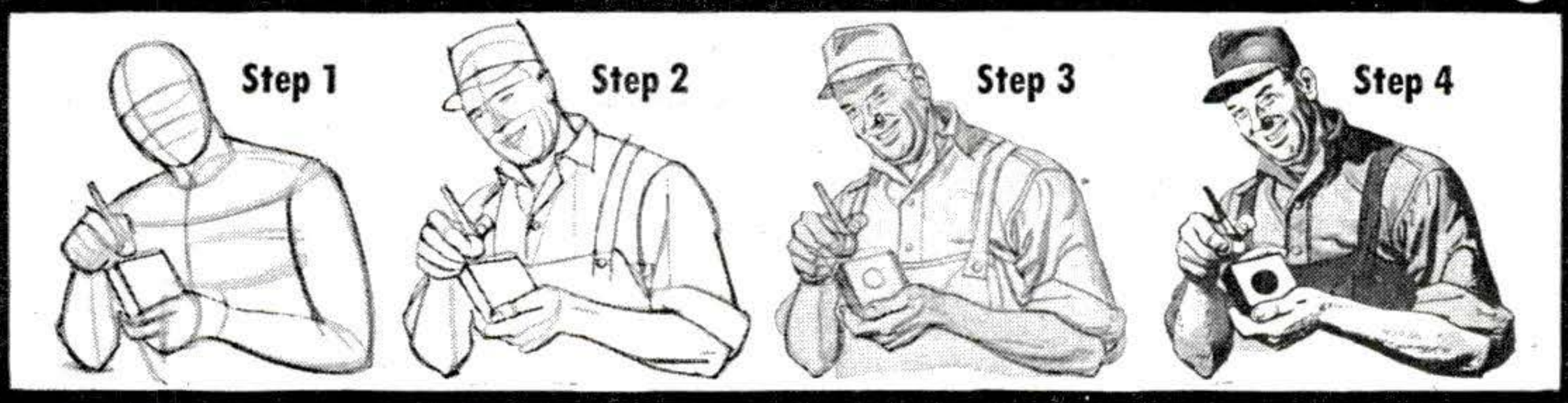

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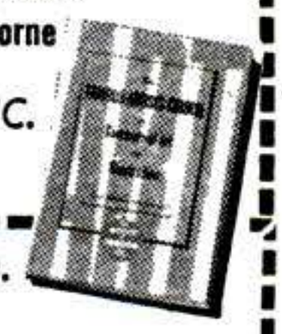

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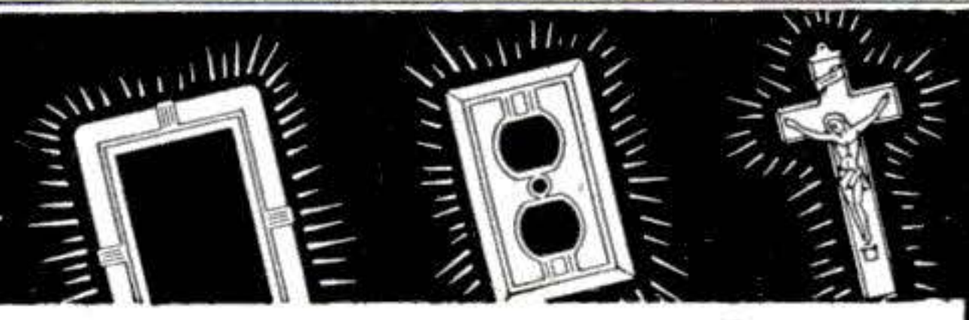

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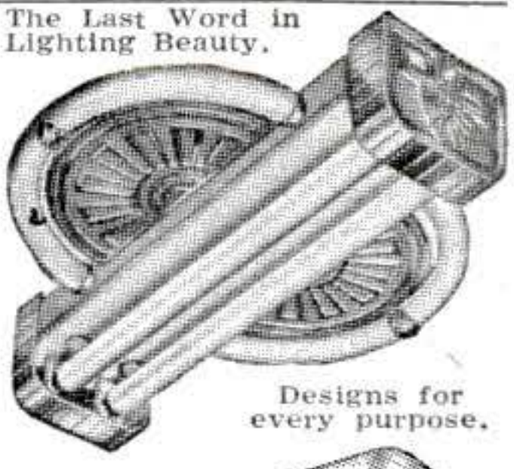

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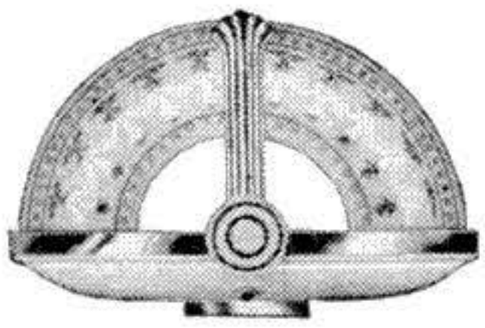

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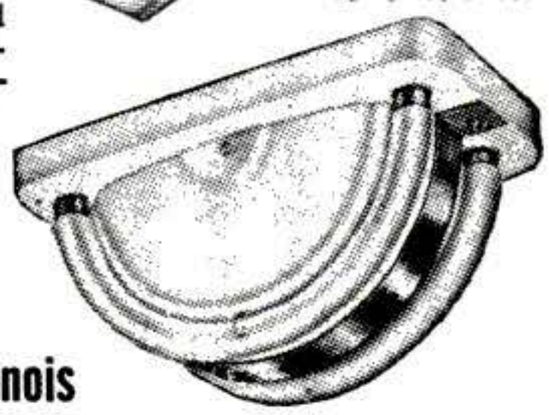

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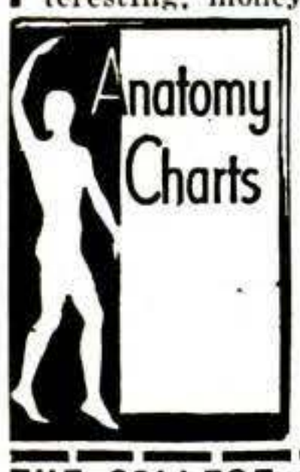

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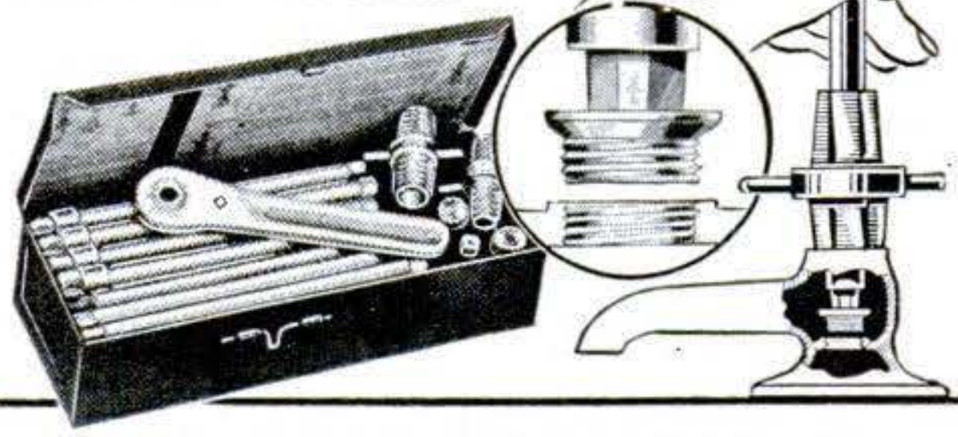

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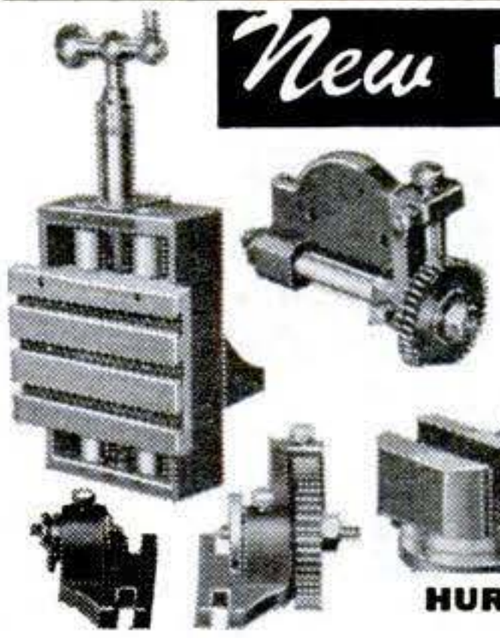

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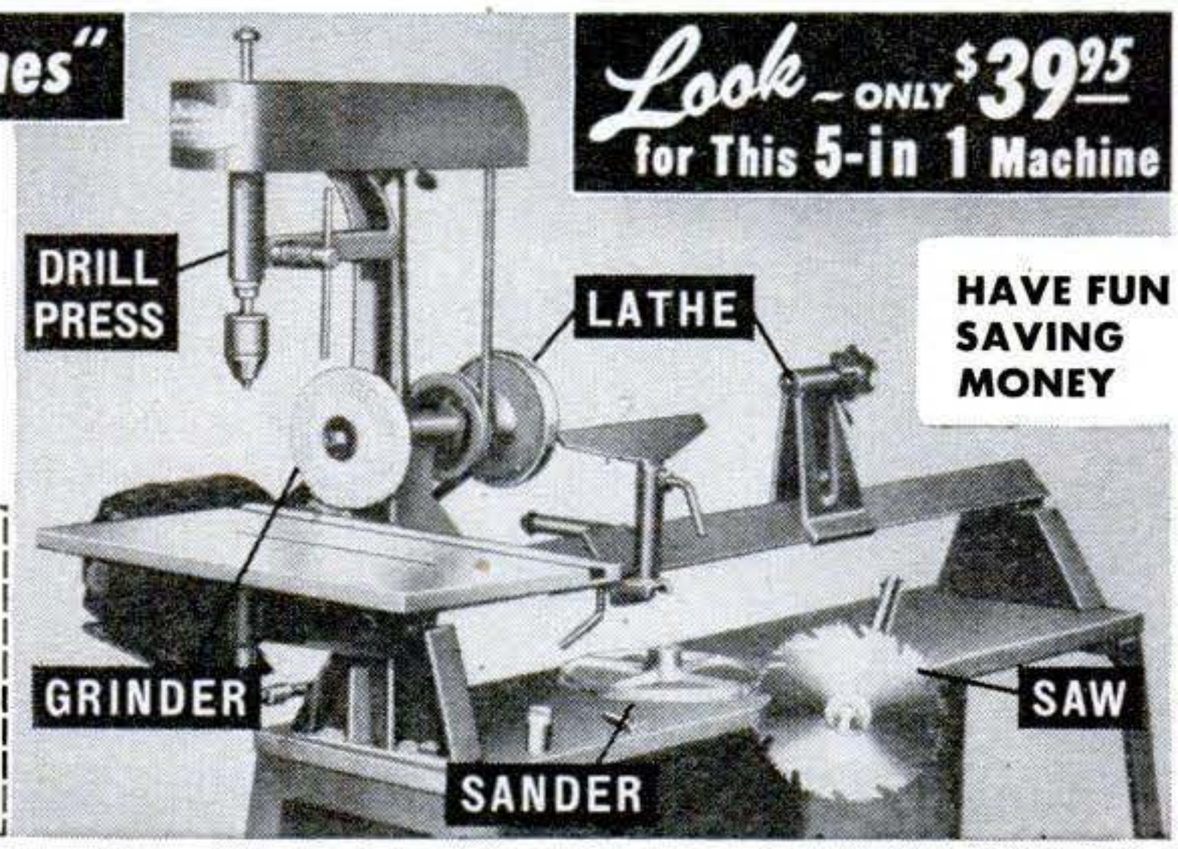

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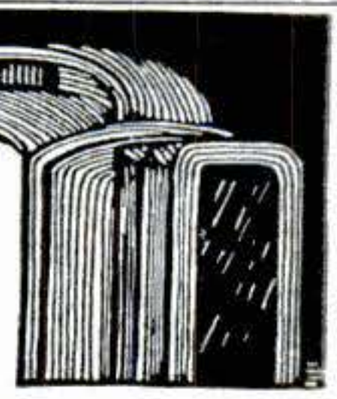

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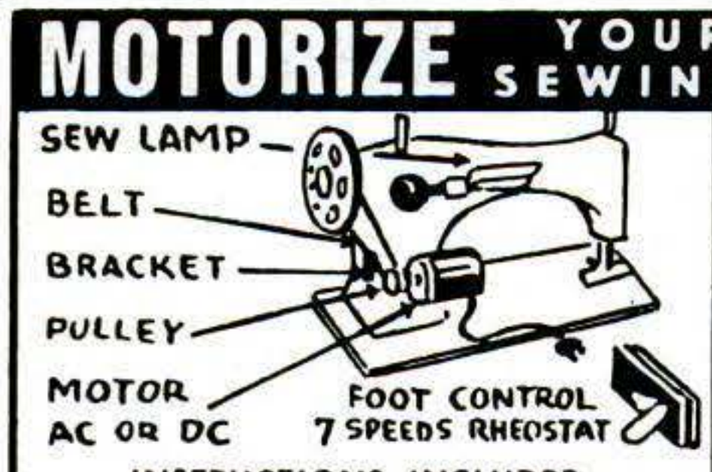

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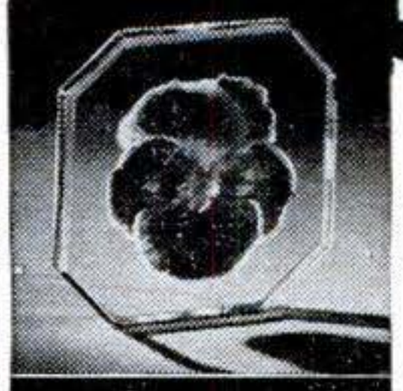

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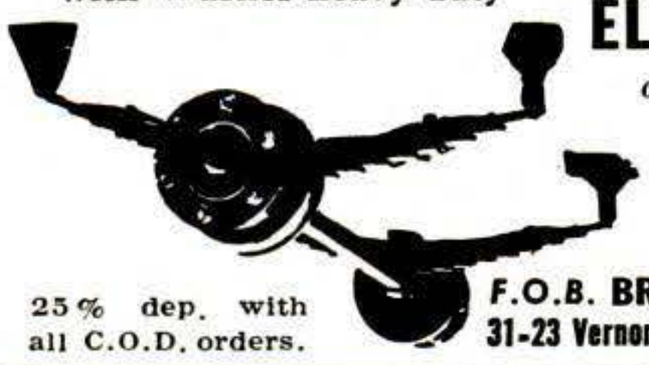

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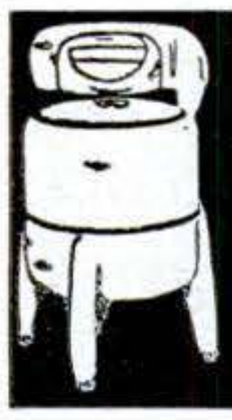

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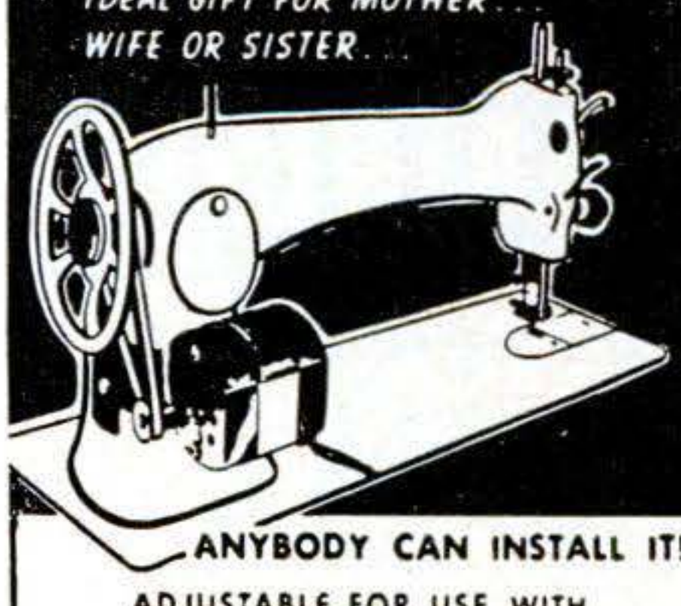

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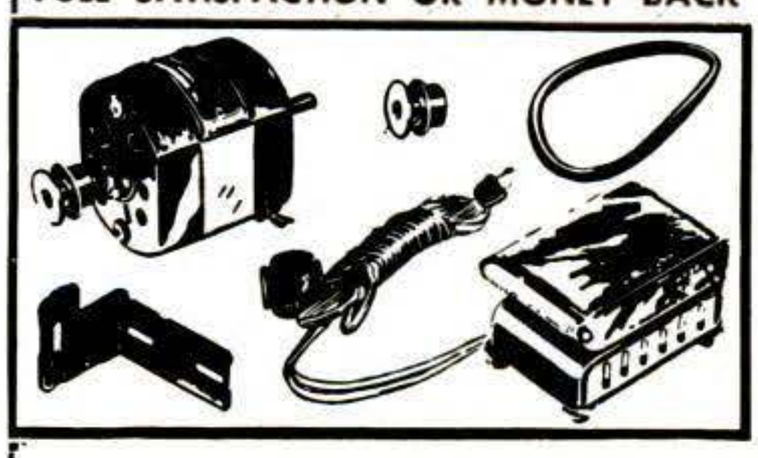

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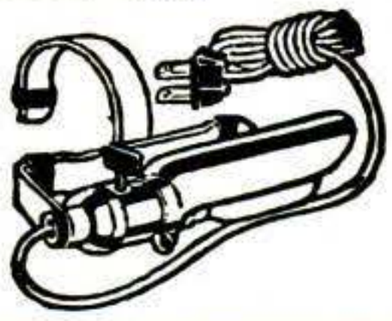

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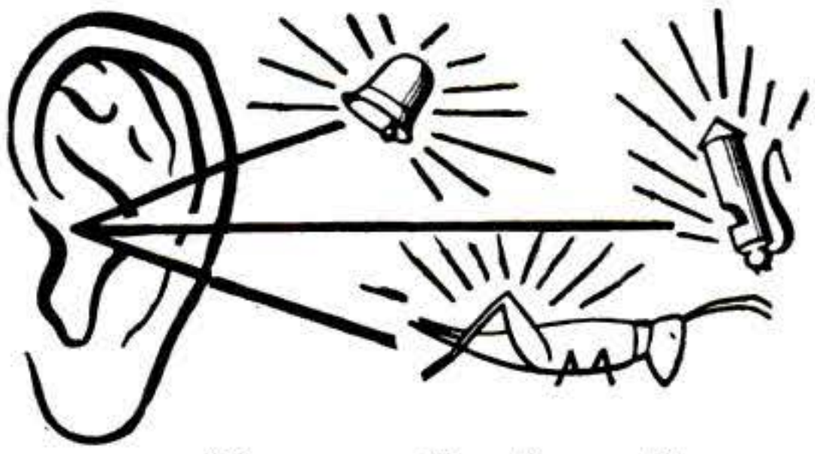

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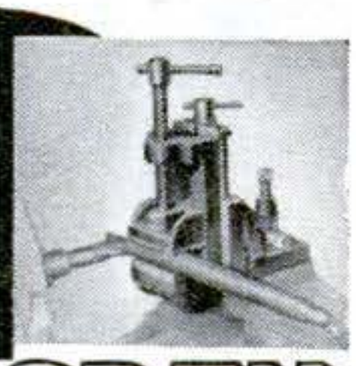

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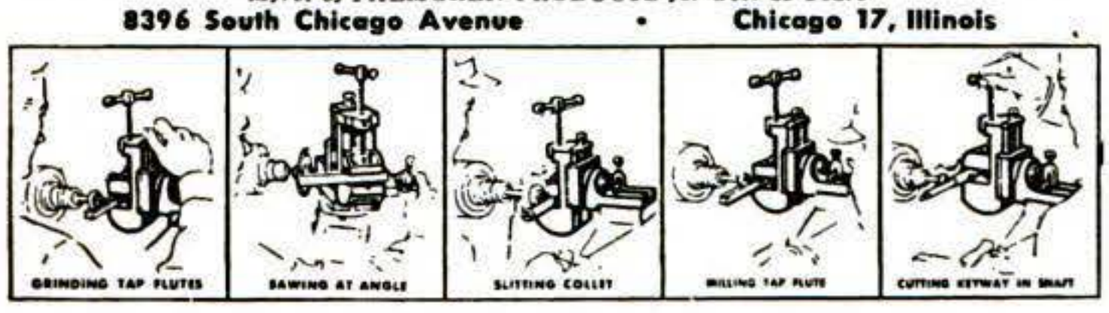

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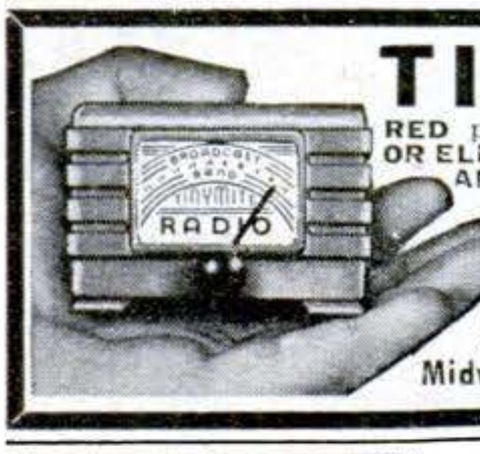

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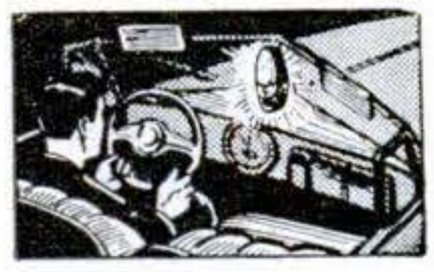

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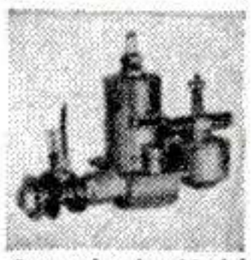

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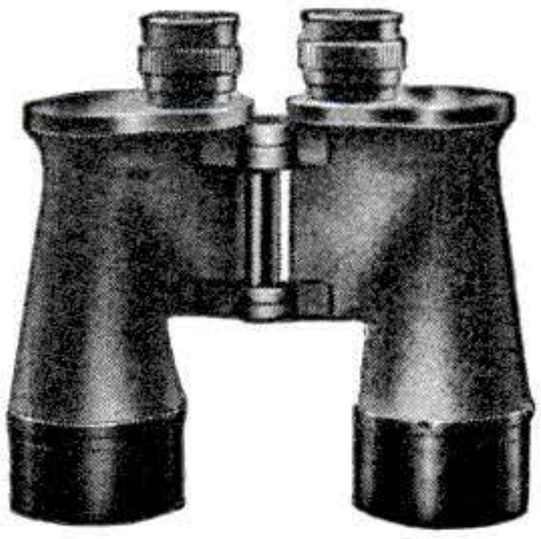

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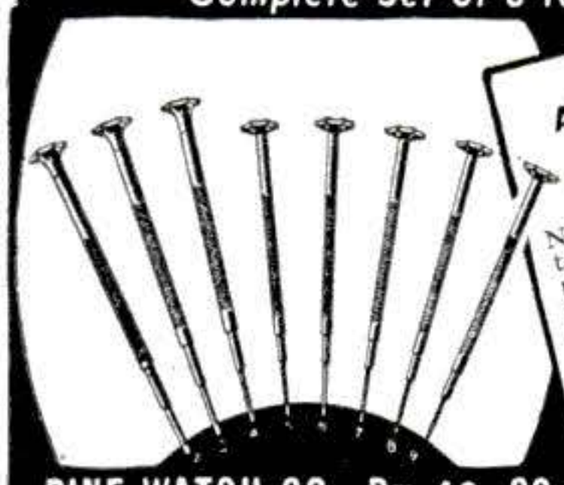

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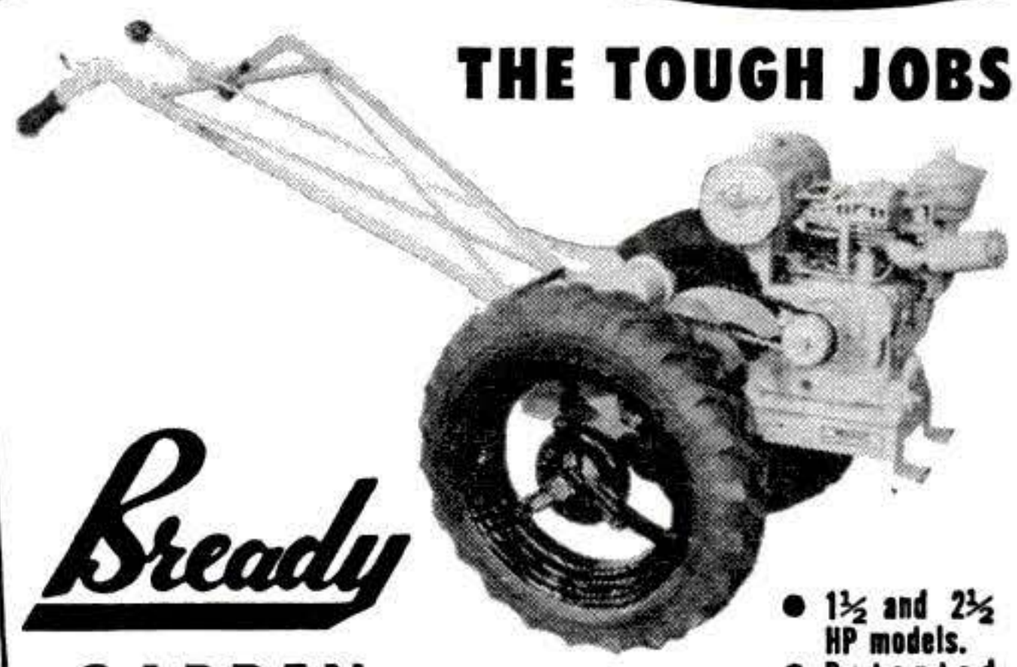

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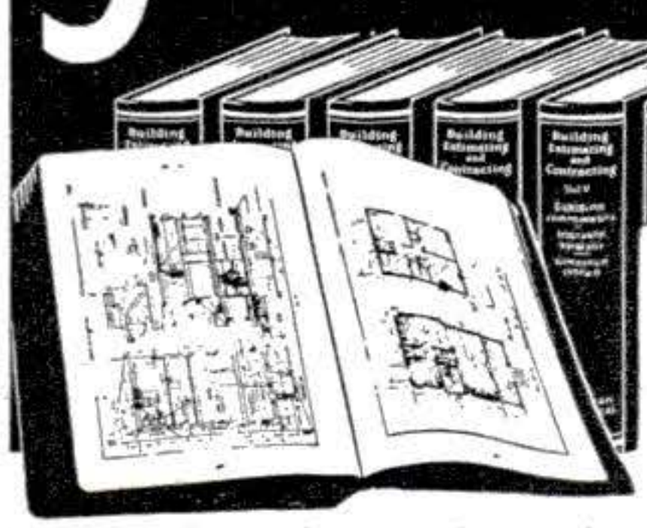

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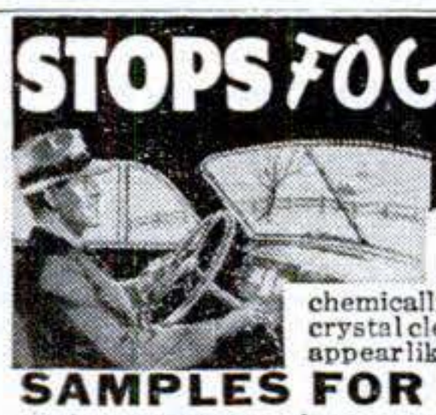

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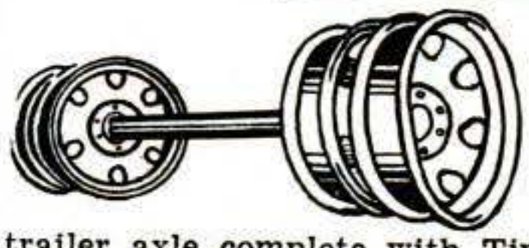

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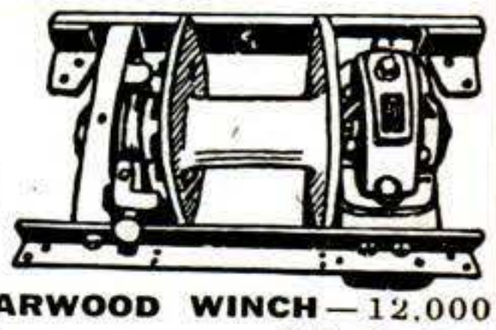

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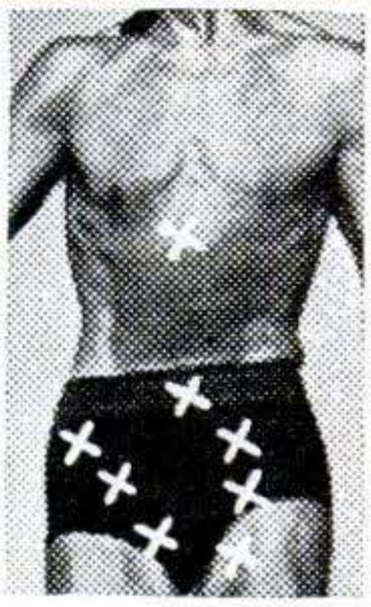

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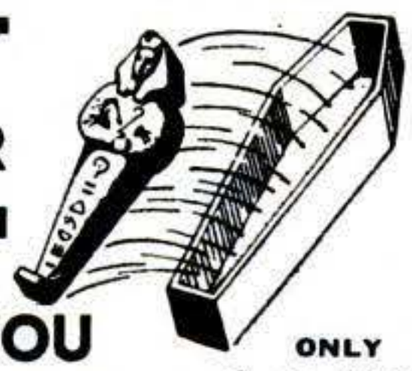

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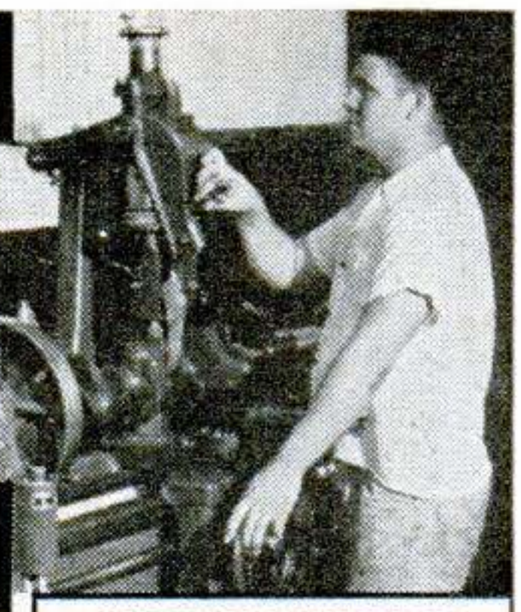

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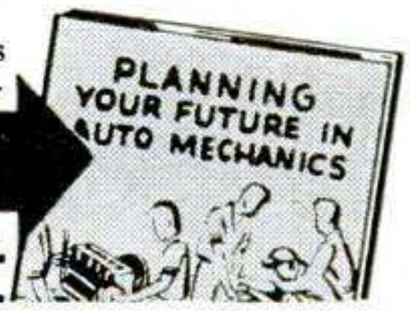

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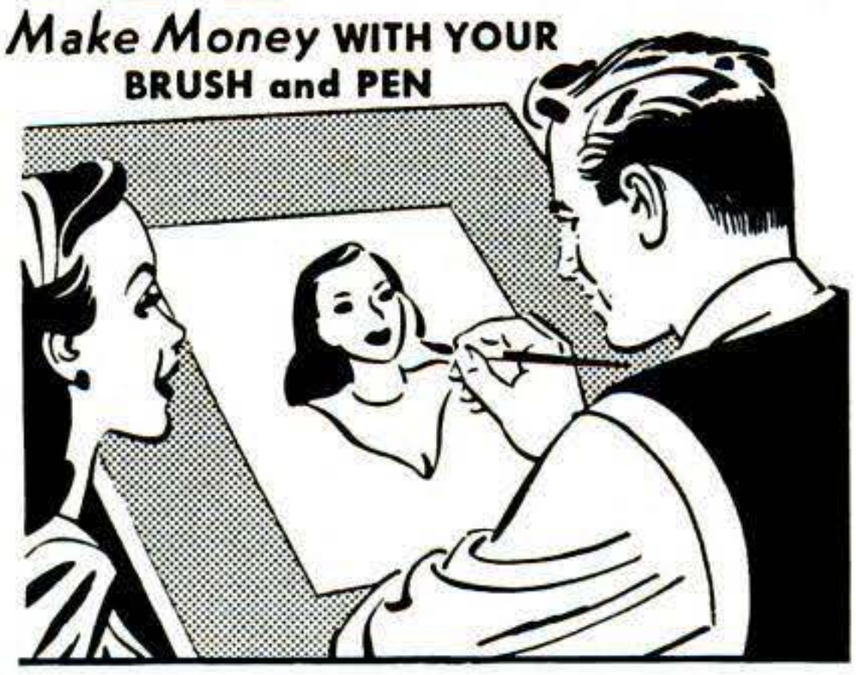

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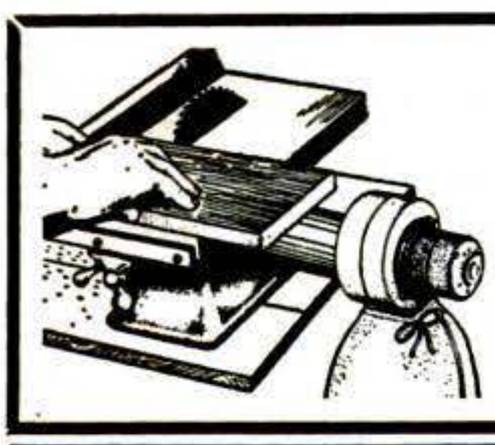

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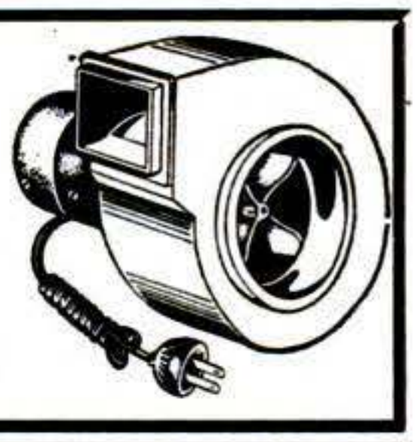

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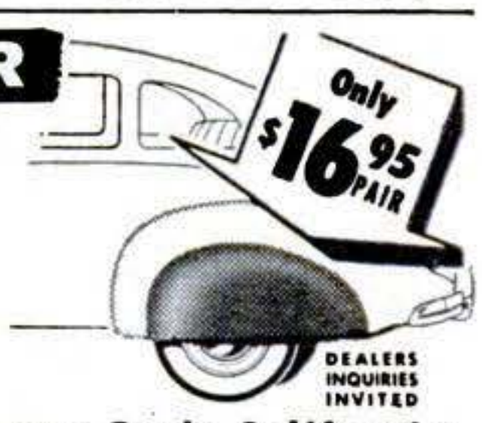

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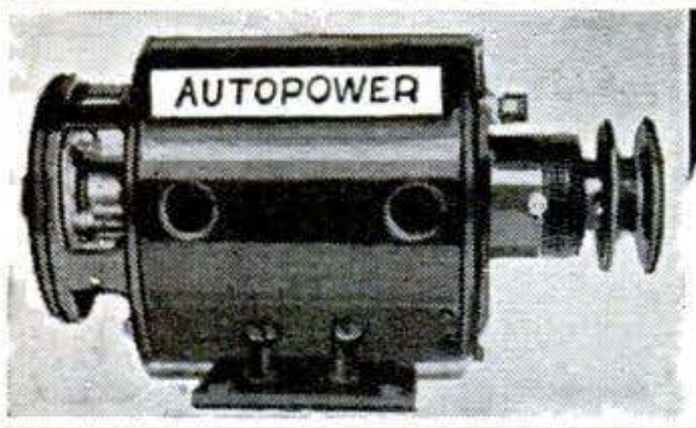

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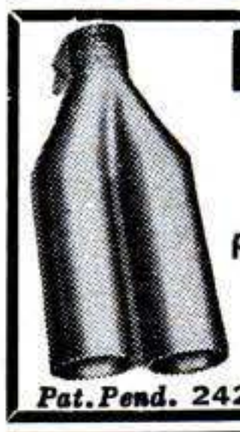

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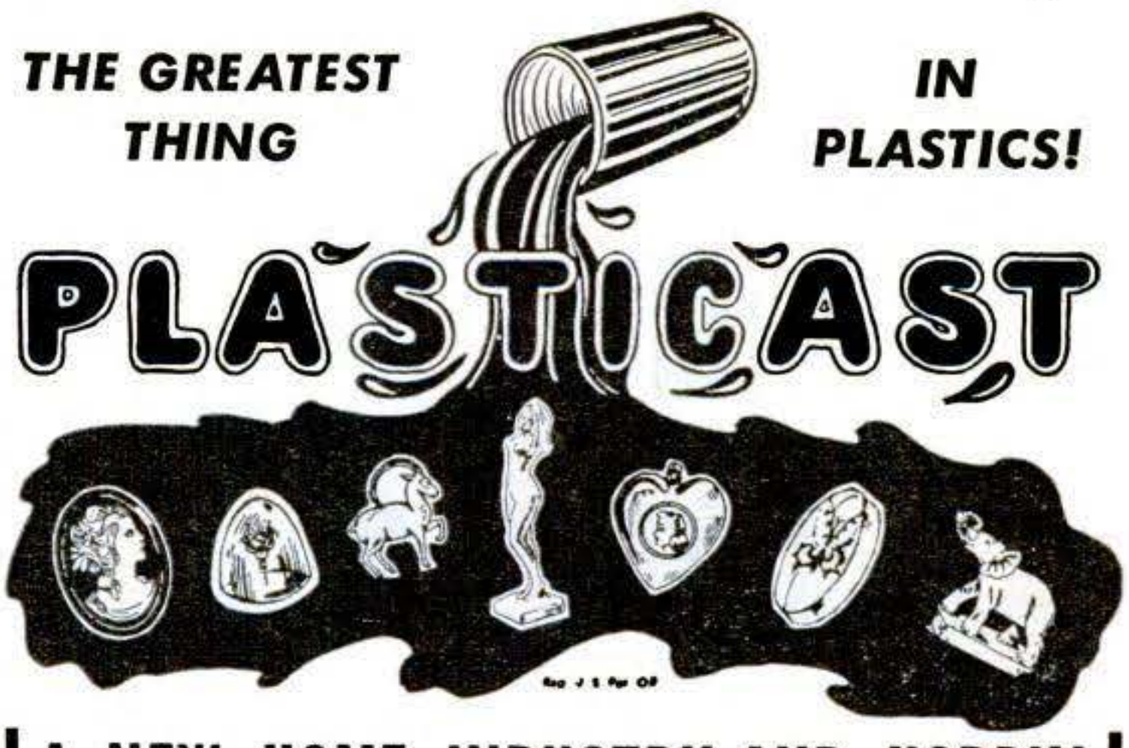

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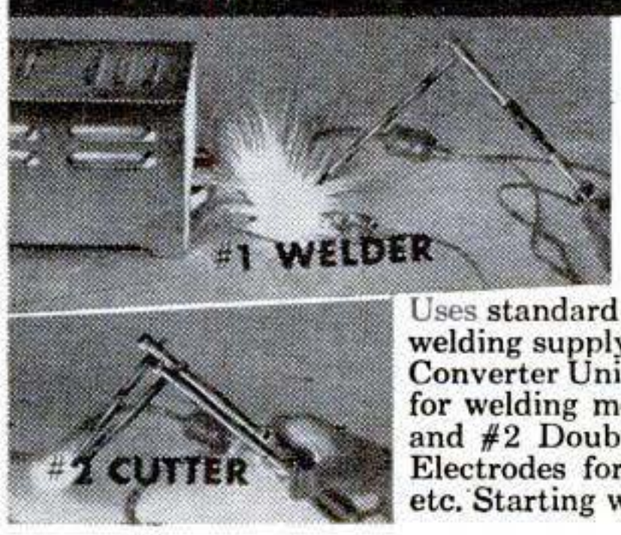

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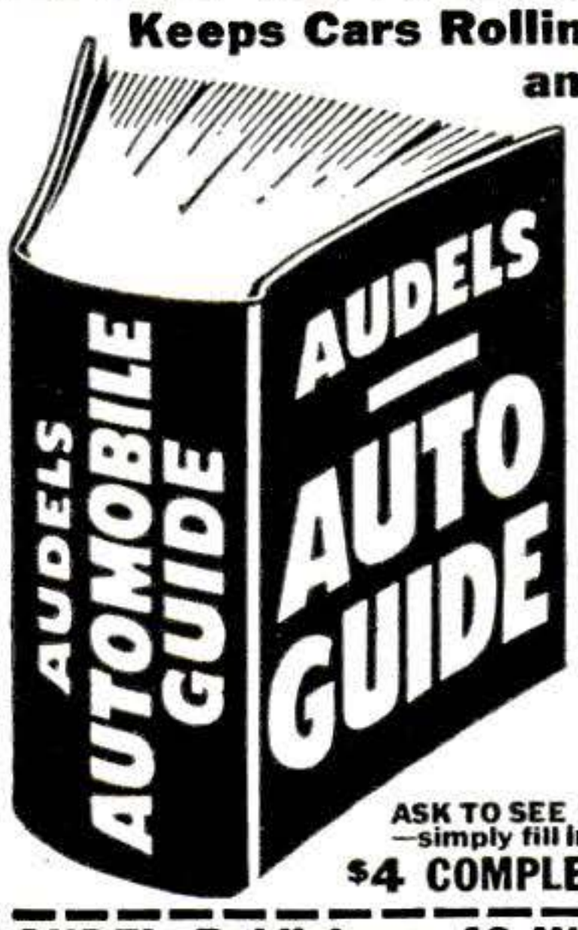

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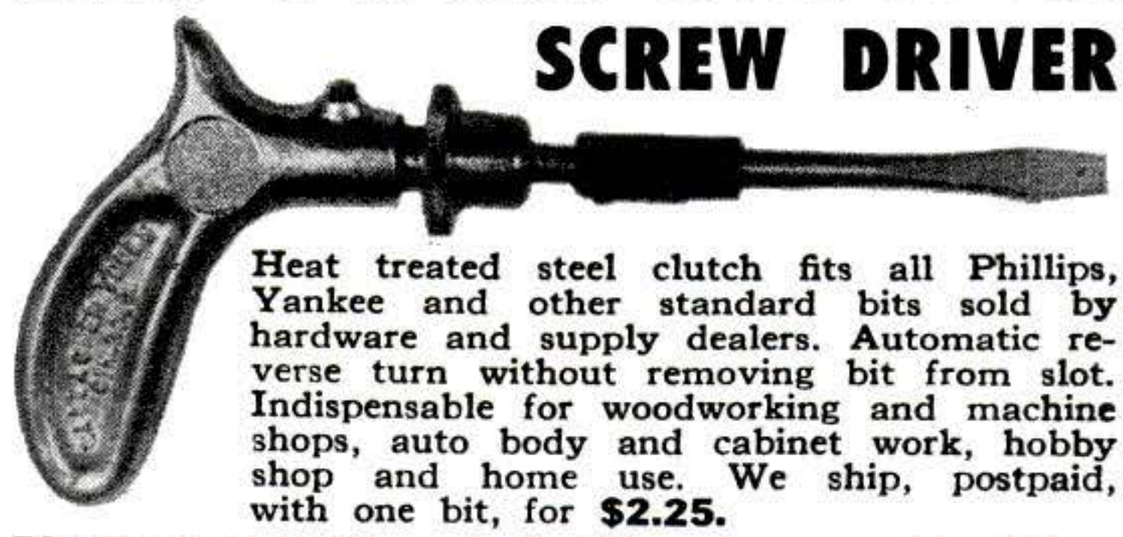

Heat treated steel clutch fits all Phillips, Yankee and other standard bits sold by hardware and supply dealers. Automatic reverse turn without removing bit from slot. Indispensable for woodworking and machine shops, auto body and cabinet work, hobby shop and home use. We ship, postpaid, with one bit, for **$2.25.**

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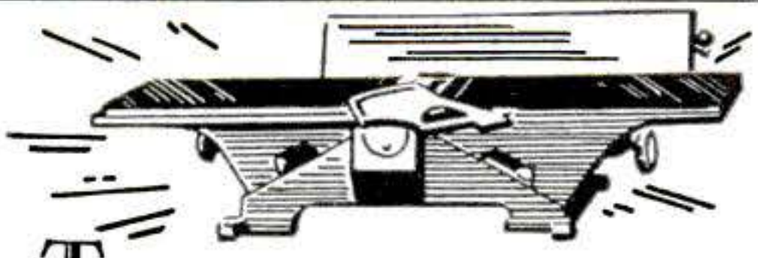

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Bore	O.D.	Type	Price
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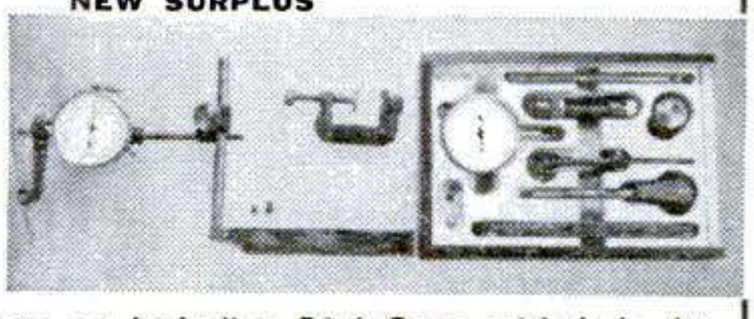

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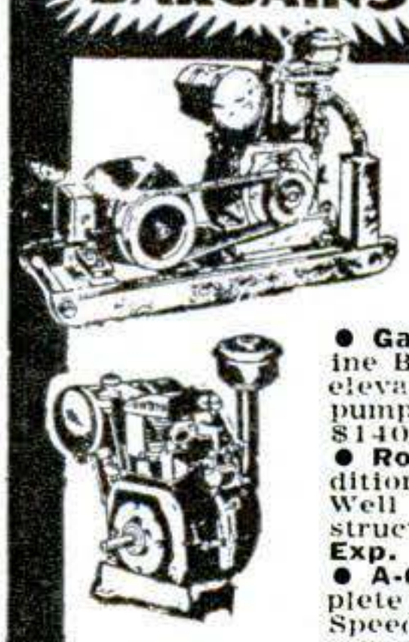

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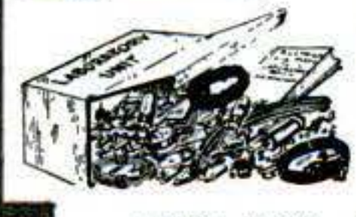

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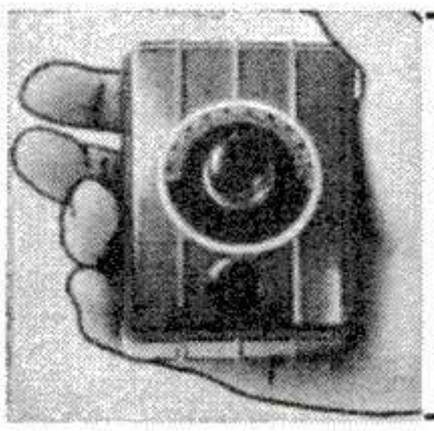

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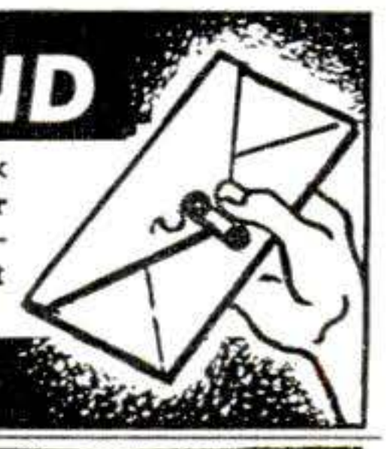

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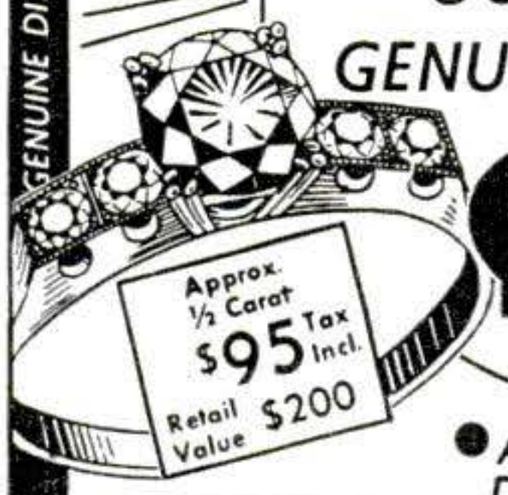

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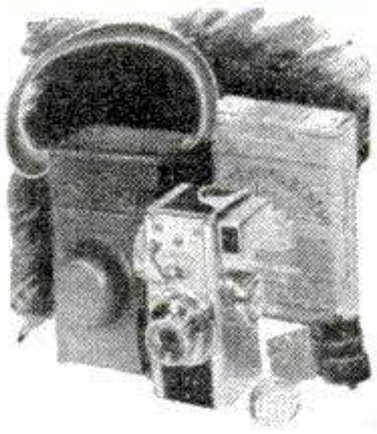

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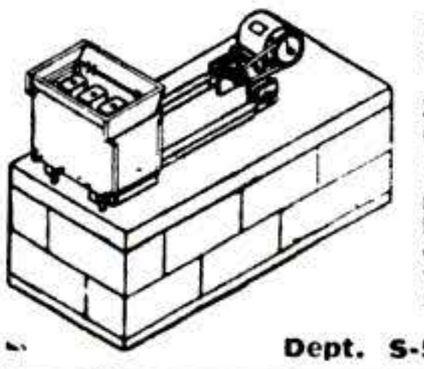

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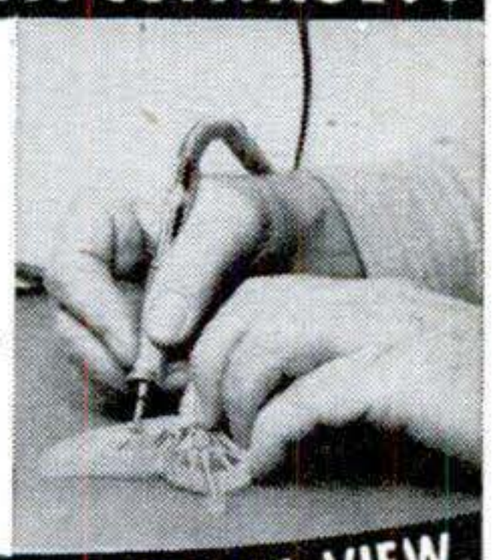

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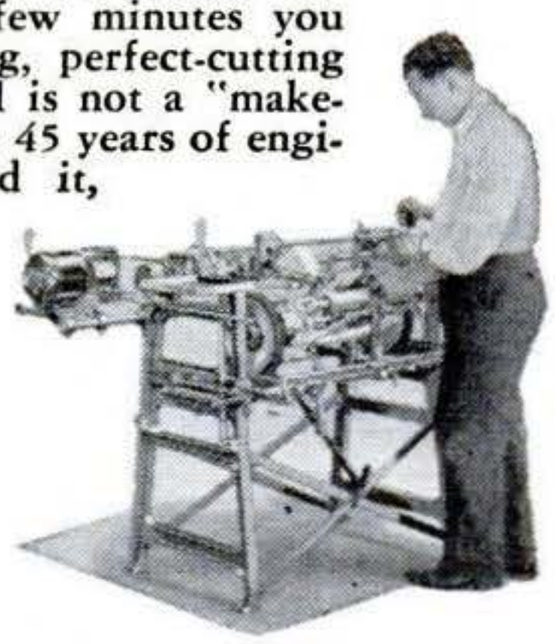

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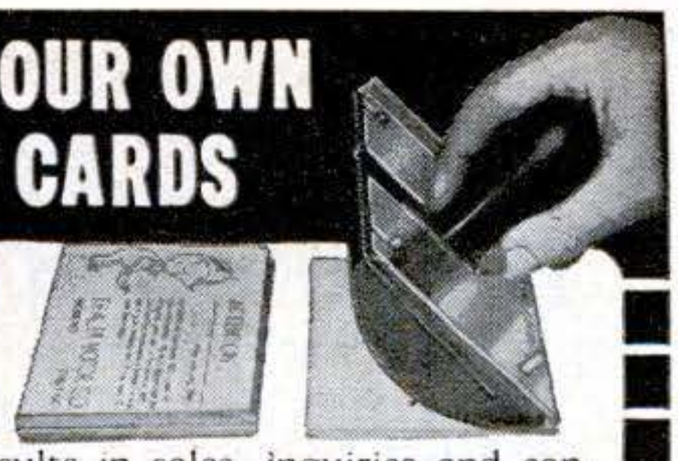

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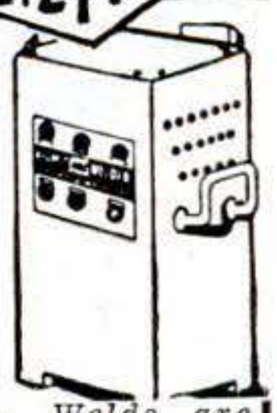

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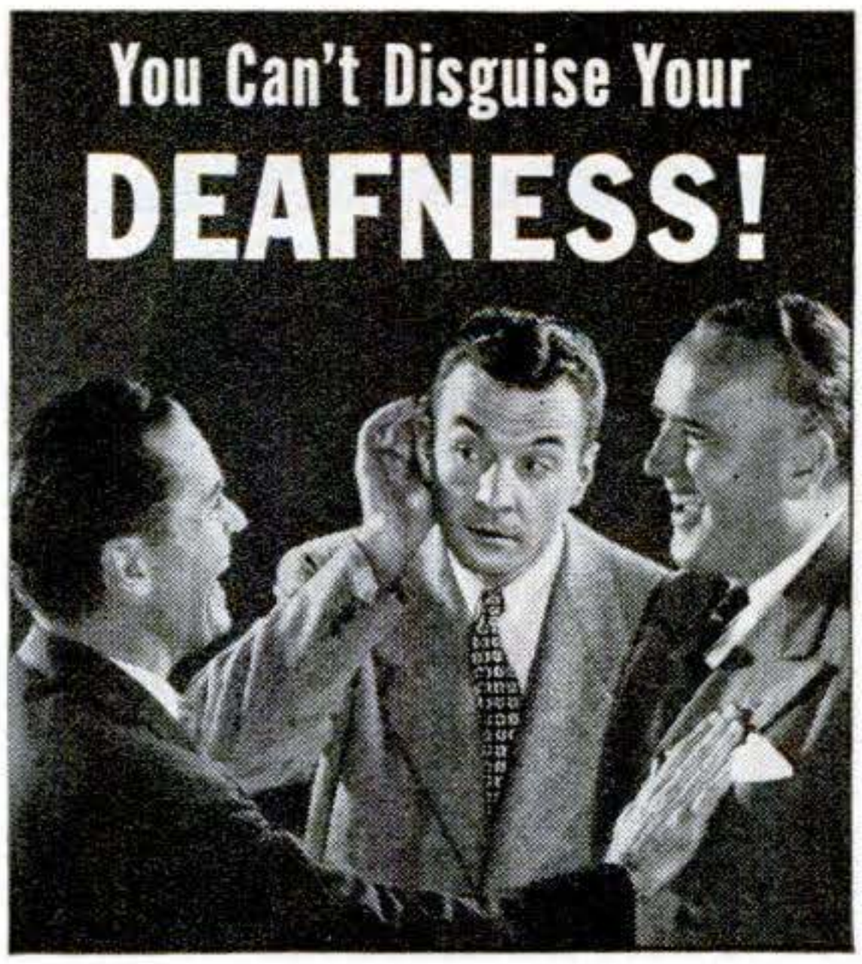

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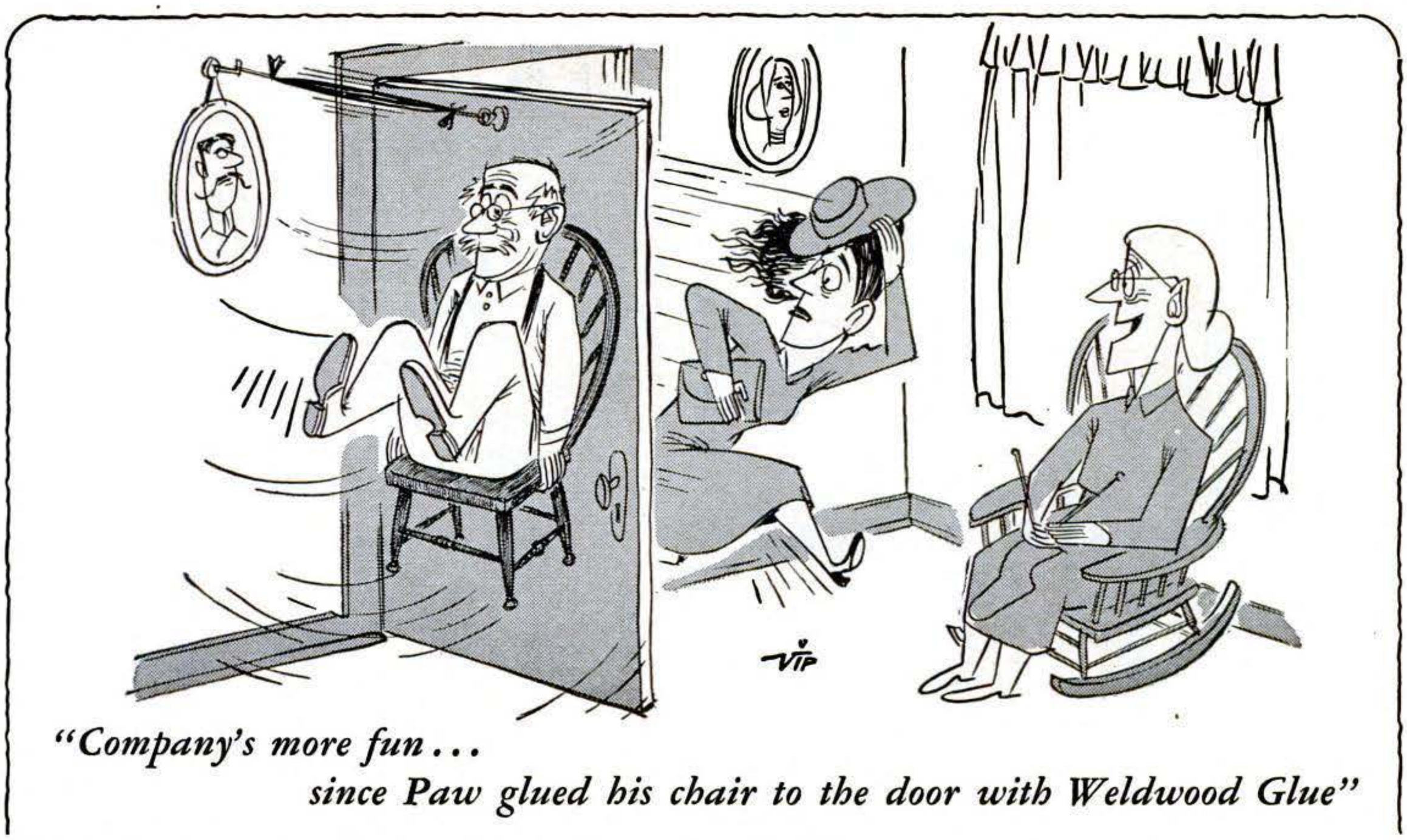

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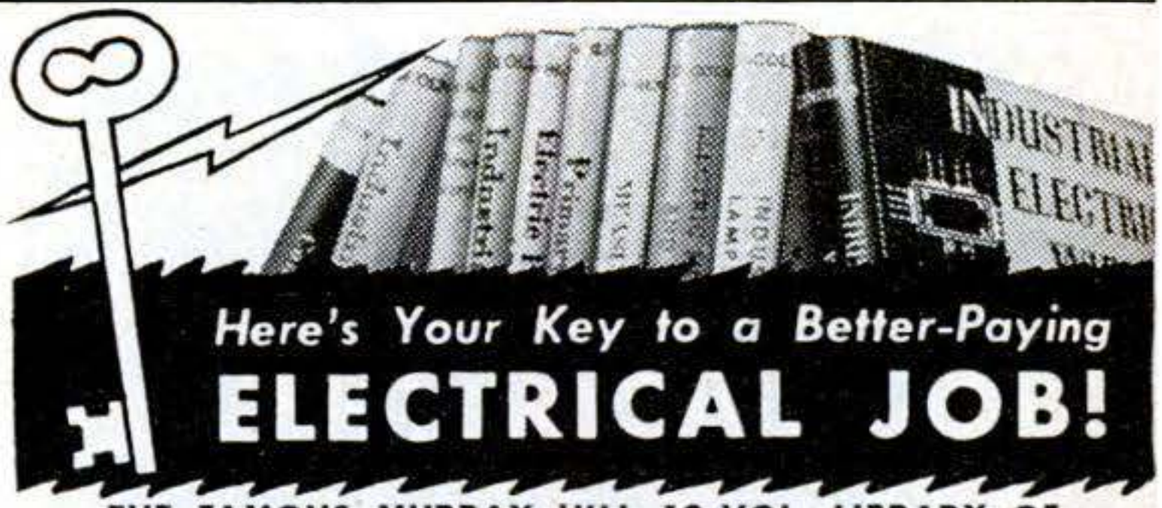

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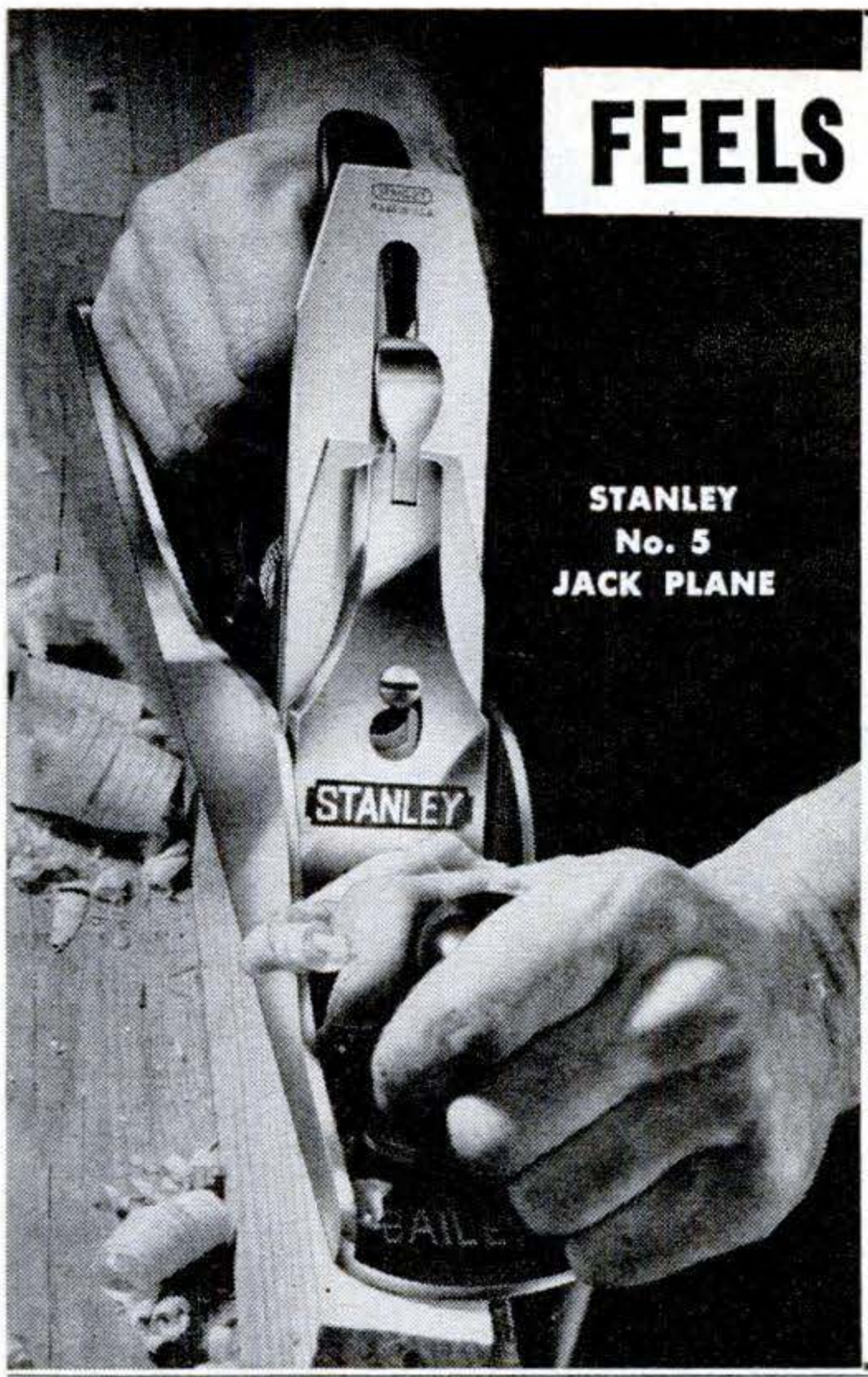

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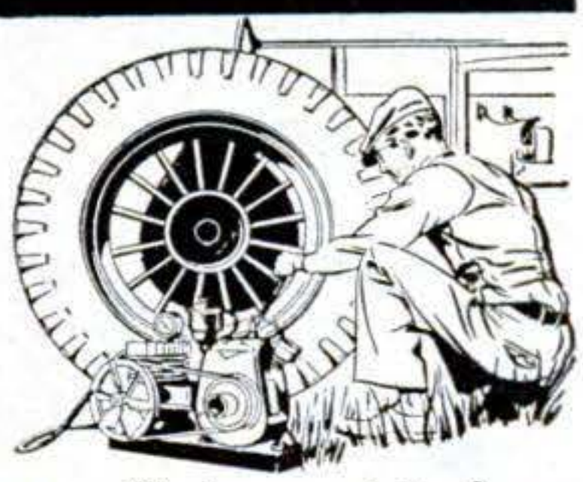

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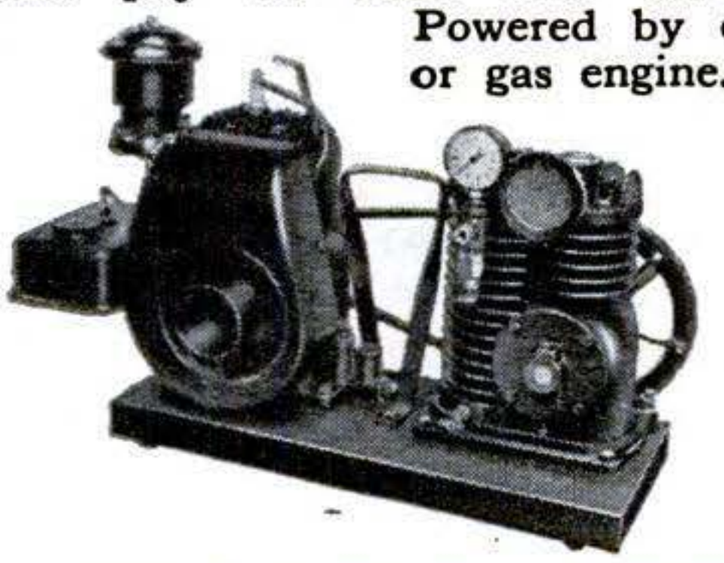

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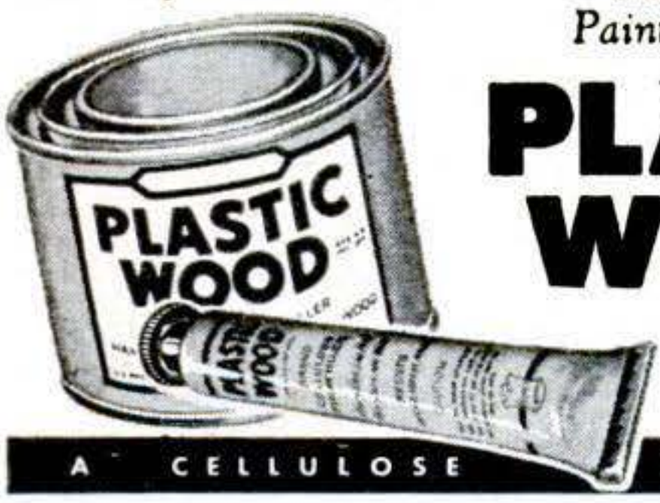

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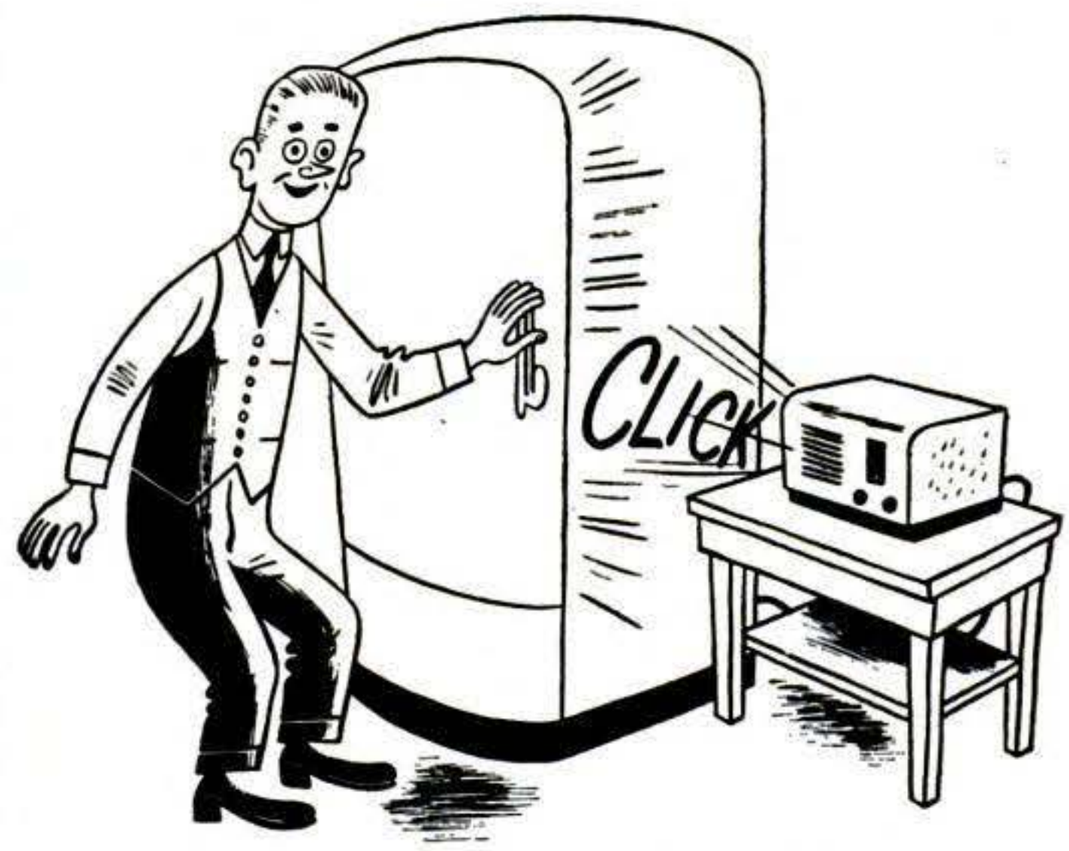

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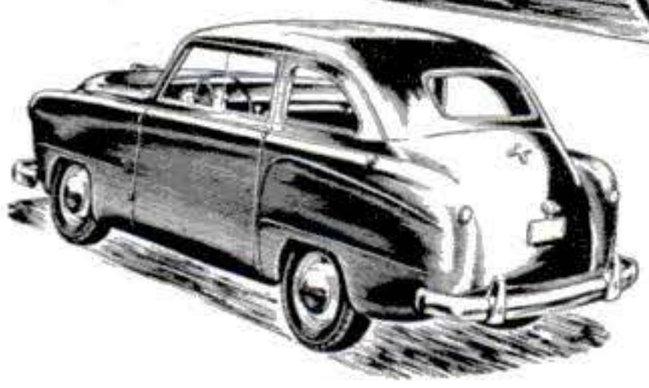

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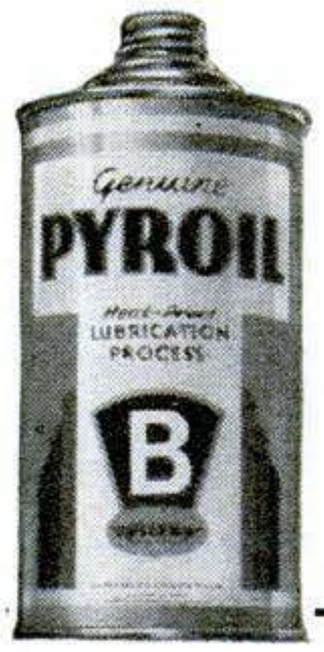

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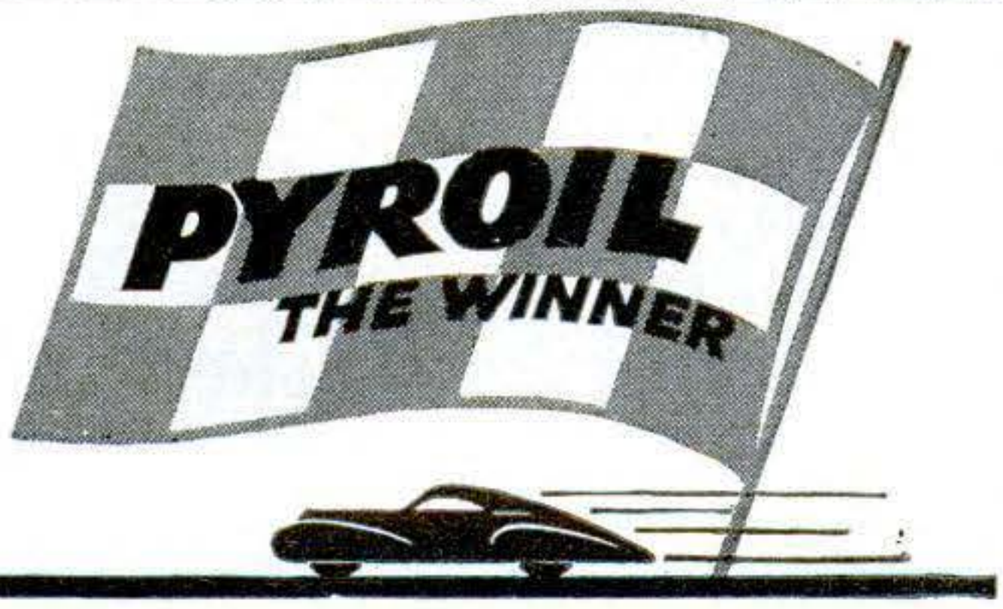

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- Automotive repairs { blocks, fenders, frames
- Fuel-oil tanks
- Contractors' welding
- Bridge work
- Construction equipment repairs { excavators, tractors, graders, ditchers, etc.
- Kitchen equipment
- Cabinet work
- Fabricated housing
- Fabricated garages
- Cast iron repairs for foundries
- Maintenance work for industrial plants
- Ventilating systems
- Bicycle repairs
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- Fabricating equipment of your own design

Built for heavy industrial use, with welding service range from 20-275 amps. Also ideal for automotive, general repair, job welding, and machine shops; foundries; schools; etc.

The only welder with easy-to-use Dial-lectric Control

Anyone can quickly learn to use the new P&H Dial-lectric welder. There is only one control — the dial is clearly marked and a ¾ turn of the radio-like knob covers the entire welding range. There are no plug-ins to make, no wheels or levers to crank or adjust — welding is just plain easy with a P&H Dial-lectric machine. A clearly illustrated, easily understood welding manual is supplied with each machine so that beginners can learn to weld in an extremely short time. Old hands may pick up some new tricks, too.

No maintenance is needed

Dial-lectric control eliminates all moving parts. That is why P&H AC Welders require no attention or maintenance — why operating costs are lower — why so many industrial users are switching to this new welder. Also, NEMA rating assures you of long life and dependable operation.

You produce sounder, better-looking welds in a shorter time

The P&H remote control feature permits proper heat selection at the job. You waste no time or energy walking back and forth to the machine to make adjustments. There is no temptation to skimp — remote control lets you use the right heat. Welds are sound and better looking. Work is done faster. Additional features that make for better, faster welding are: Easy quick-start arc. High-low welding range. Elimination of arc blow.

Requires only 2¼ feet of floor space

You can put a Dial-lectric welder most any place — it is connectible for 220 or 440 volts. Despite its weight of 307 lbs., it is remarkably compact. The Dial-lectric is easy to move around, too — it's mounted on wheels, you handle it just like a hand truck.

A complete electrode service is provided by convenient P&H Shop Packs

P&H Shop Packs contain eight different packages of electrodes. Detailed instructions are printed on each individual package so that you can use the right electrode for every job. Guesswork is eliminated. Welds are stronger, better-looking. You can weld anything made of steel, alloy or stainless steel, sheet metal, cast iron. You can put hard, protective, long-life coatings on new parts, or build up worn parts better than new. The cost of all 8 types, individually packaged and labeled for your convenience, is only $11.75.

It pays to use P&H electrodes. No matter what make of welder you have, order a P&H shop pack today from your nearby P&H distributor.

Reduce welding costs in your plant or business

If you are connected with, or are interested in welding, use your influence to bring in a P&H Dial-lectric AC Welder. A comparison of its performance with that of other units quickly shows that a Dial-lectric improves the quality of the welds, speeds the work, and reduces costs.

A P&H Dial-lectric AC arc welder can be purchased for as little as $209.75. Also get P&H Shop Pack electrodes ($11.75). You will want to standardize on these weld rods after you have checked their speed, quality, easy manipulation, and great variety of uses. Contact your nearby P&H distributor, or send in coupon below, clipped to your business letterhead.

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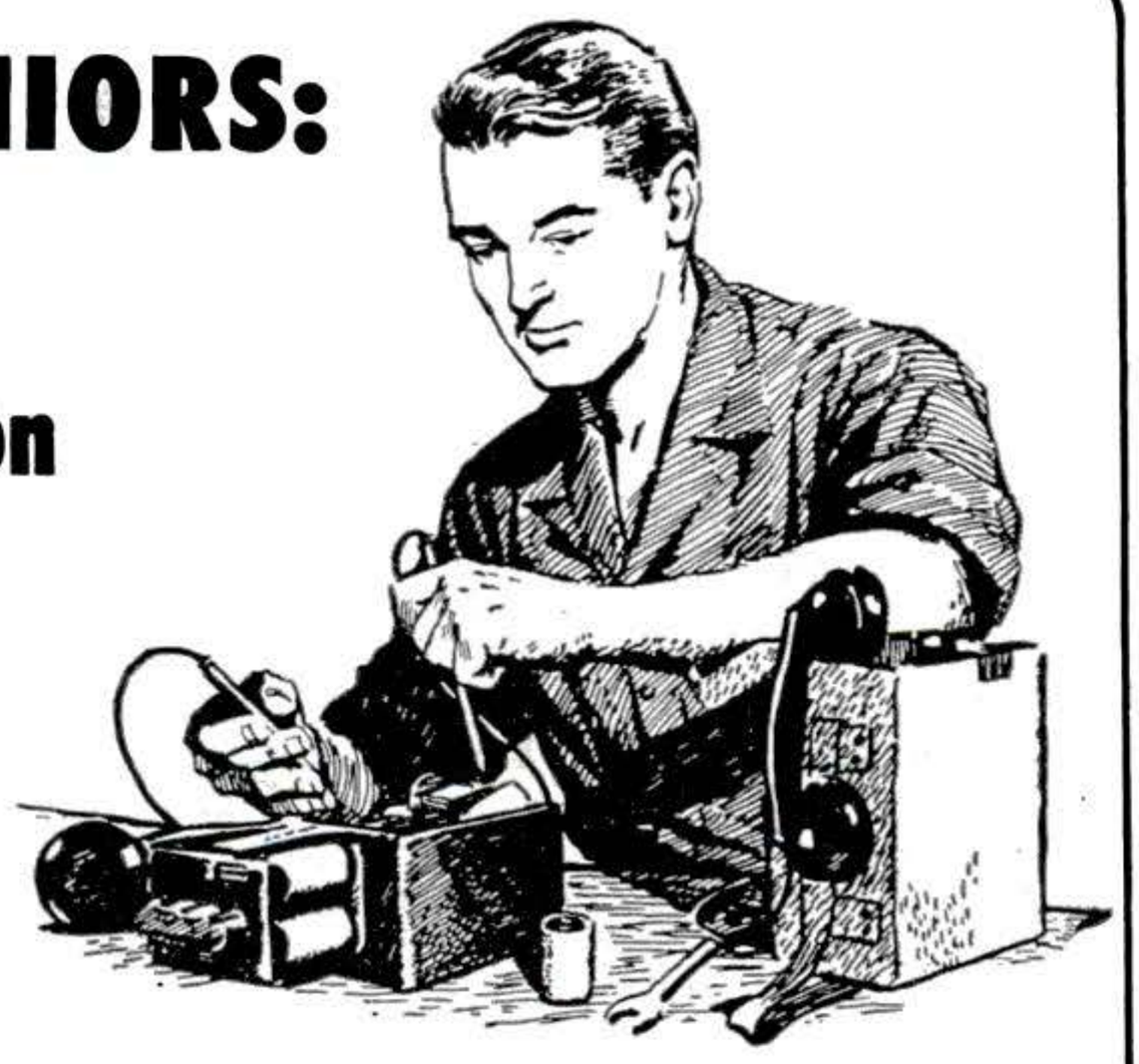

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When you finish high school in January or June, plan to complete your education in one of the U. S. Army specialty schools. You'll get good pay while learning, plus free board and room, free clothing and equipment, medical and dental care. And you'll share in the U. S. Army's great retirement plan. After you have finished high school, select the army course you want. Get the facts . . . without obligation . . . at your nearest U. S. Army Recruiting Station.

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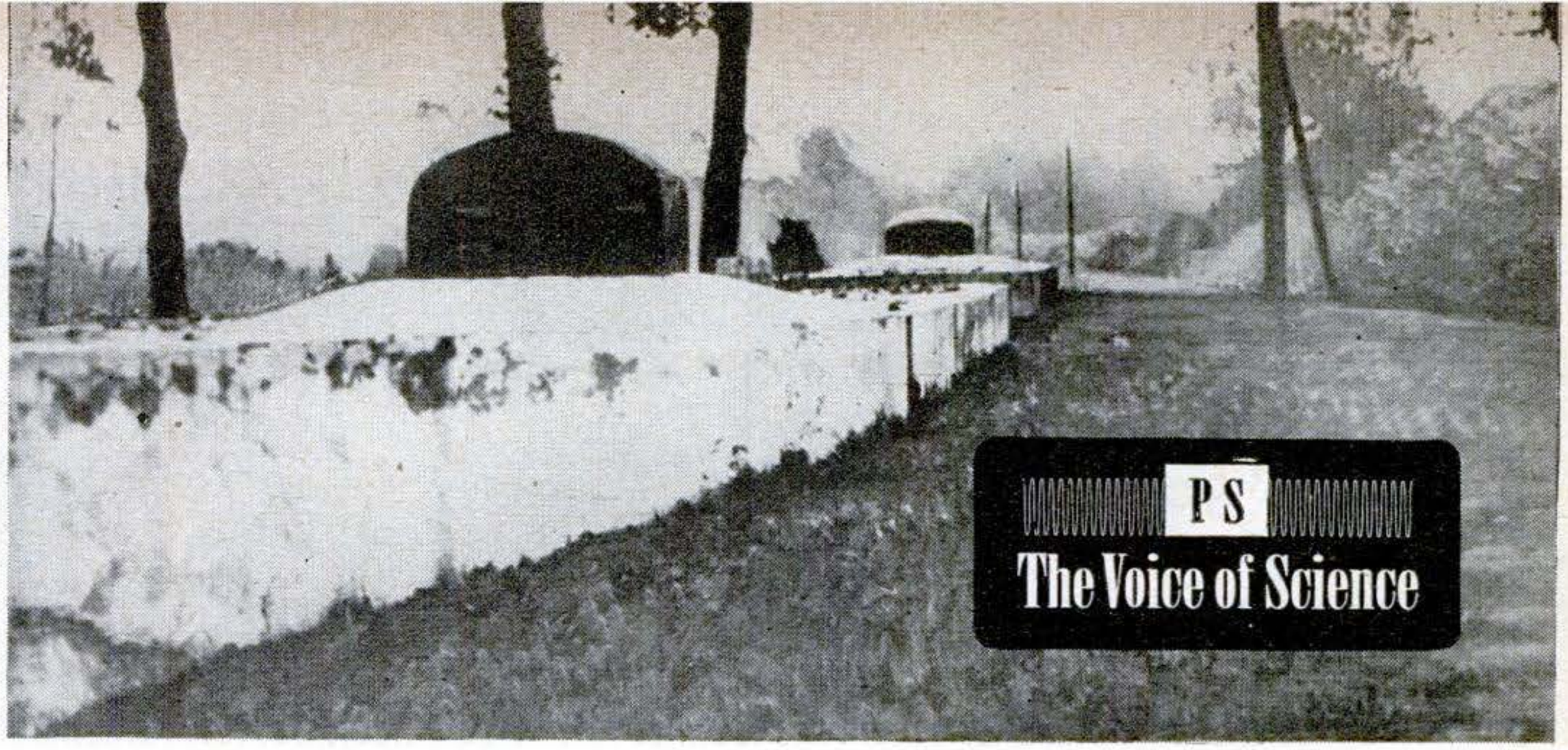

An Atomic Curtain? Feasible Nonsense!

AN ominous idea has slithered into print. It is to use the knowledge and products of nuclear fission to drape an invisible veil of death this side of the iron curtain.

This gruesome thought can hardly be dismissed as another fantasy of the science fictioneers. For it was aired by a couple of ordinarily shrewd and sober commentators, Joseph and Stewart Alsop, whose syndicated column is datelined "Washington."

Even if the idea were not instigated by certain military minds, it must come with grateful logic to those who think of the A-bomb as "just another weapon." Those who hopefully quote history that every weapon has had its counterweapon and defense.

Technically, the thing is possible. The very scientists who burst the atom would breech no national secrets in confirming that it could be done. There are plenty of hints in the Smyth Report of the deadliness of fission products. There are the mute "survivors" of Bikini. The plague ships still anchored in isolation; the death ships buried at sea because they were too hot for human seed and tissue.

One possibility is to play the *real* death rays from cyclotrons or uranium piles like searchlights at strategic points. Or a radioactive Maginot Line could be drawn across whole continents by laying mine fields of isotopes. Plutonium, itself, could be dusted like DDT on crops. Or a border strip, suitably marked off, might be used as a dumping ground for atomic wastes.

The quickest way to create a literal no man's land would be to announce that such and such areas were to be "dehumanized" in X hours. Allowing barely enough time for people to get out, and not quite enough for troops to get in. Then simply drop an A-bomb every X miles. This would certainly set up a quarantine zone. Quite likely, it would also start the very war it was supposed to prevent.

But the real threat of an atomic curtain, it seems to me, would be its effect on those it would presumably protect. We would find ourselves in the sad position of the lunatic who thought the barred windows and high walls were to keep the *other* people *out*.

We ought to know by now that every Chinese Wall or Maginot Line ever built has been cracked by direct attack or cancelled by an end-around play. The static defense, like the "burglarproof" safe, cannot exist in a world of forces in motion.

Just beefing up a Maginot Line with radioactivity doesn't change this basic truth. And there's always the chance that atomic cannon so located would be turned against the defenders.

Those behind the dangerous idea of an atomic curtain may think that their proposal to use fission *defensively* somehow makes it more manageable in sword-and-armor terms. Perhaps they hope this will be the answer to the scientists who warn that atomic war will be plain suicide on an international scale.

Perry Gilkeys

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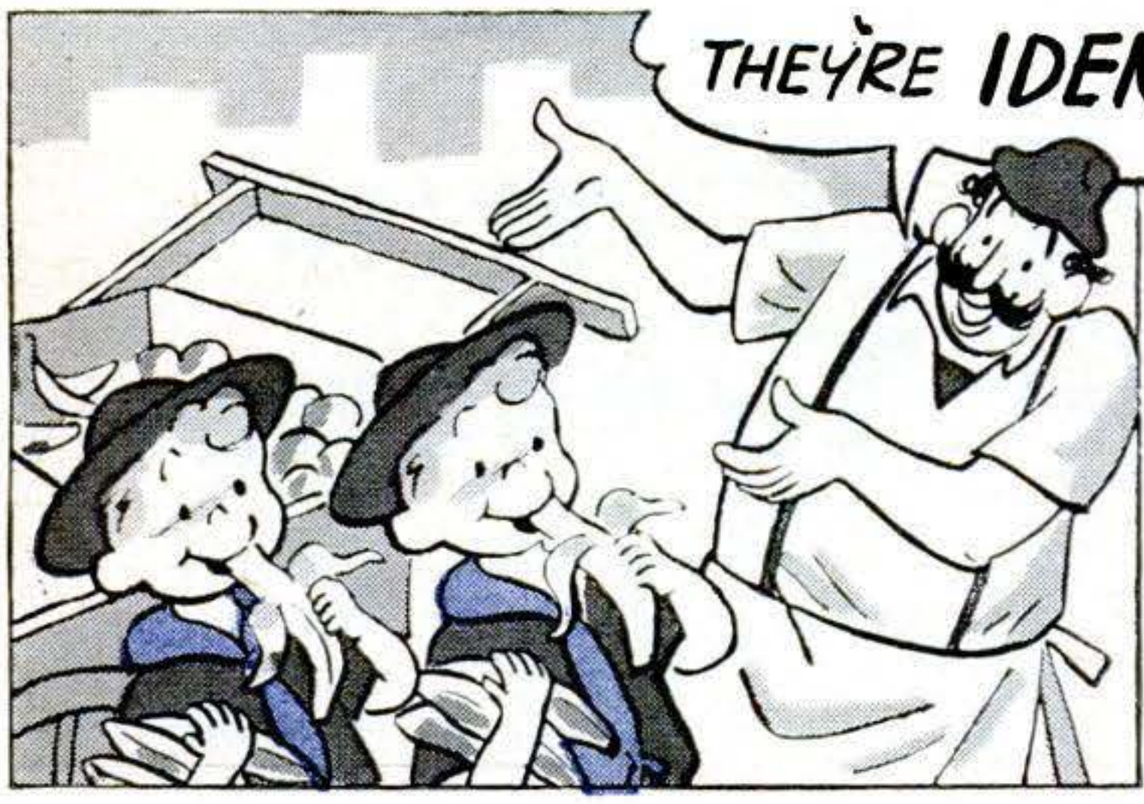

When your Ford needs a new part, make sure it's a Genuine Ford Part, an identical twin to the part built into your Ford at the factory. That saves you time and money and adds many extra years to your Ford's life.

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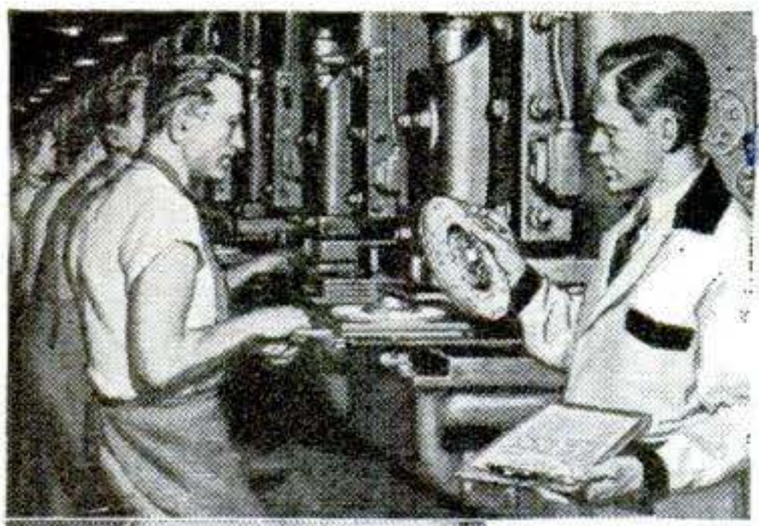
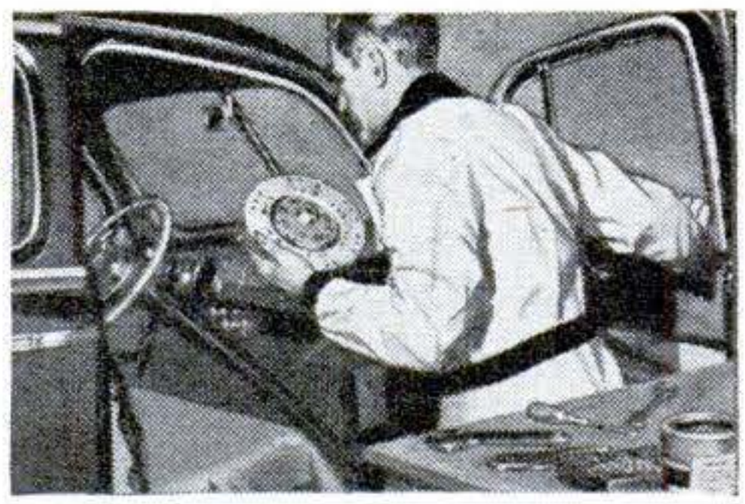


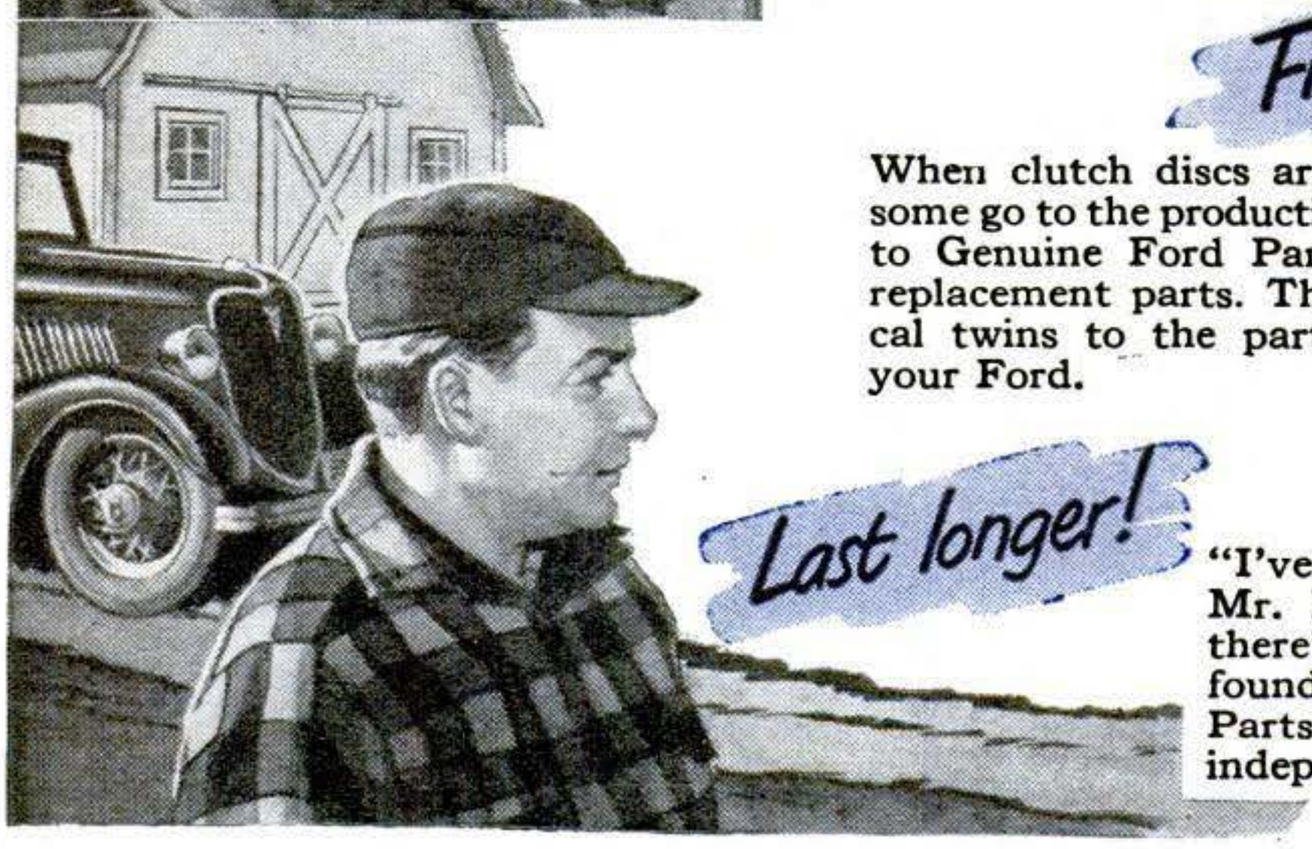
Made right

Ford engineers know the vibration of an "off balance" clutch can cause serious engine trouble. That's why the clutch disc being made (at left) is carefully designed for perfect balance.

Fit right

When clutch discs are completed, some go to the production line, some to Genuine Ford Parts stocks as replacement parts. They're identical twins to the parts built into your Ford.





Last longer!

"I've driven Fords for 21 years now," says Mr. Ed Robinson of Wilton, Conn., "and there's no substitute for *real* Ford parts. I've found it pays to look for that Genuine Ford Parts sign." (At all Ford Dealers and selected independent garages.)

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POPULAR SCIENCE
REG. U. S. PAT. OFF. Monthly

Look, Ma, No Hands!.. For years helicopter pilots have been like Don Quixote, continually jousting with their windmills. These highly unstable flying machines have demanded constant attention to the controls. But now look at Stanley Hiller's new helicopter being flown "no hands." The pilot is riding his rudder pedals, however, for helicopters with anti-torque tail rotors are still directionally touchy. Hiller is not alone in his quest for better stability. See the story of the new Kaman 'copter on page 182.

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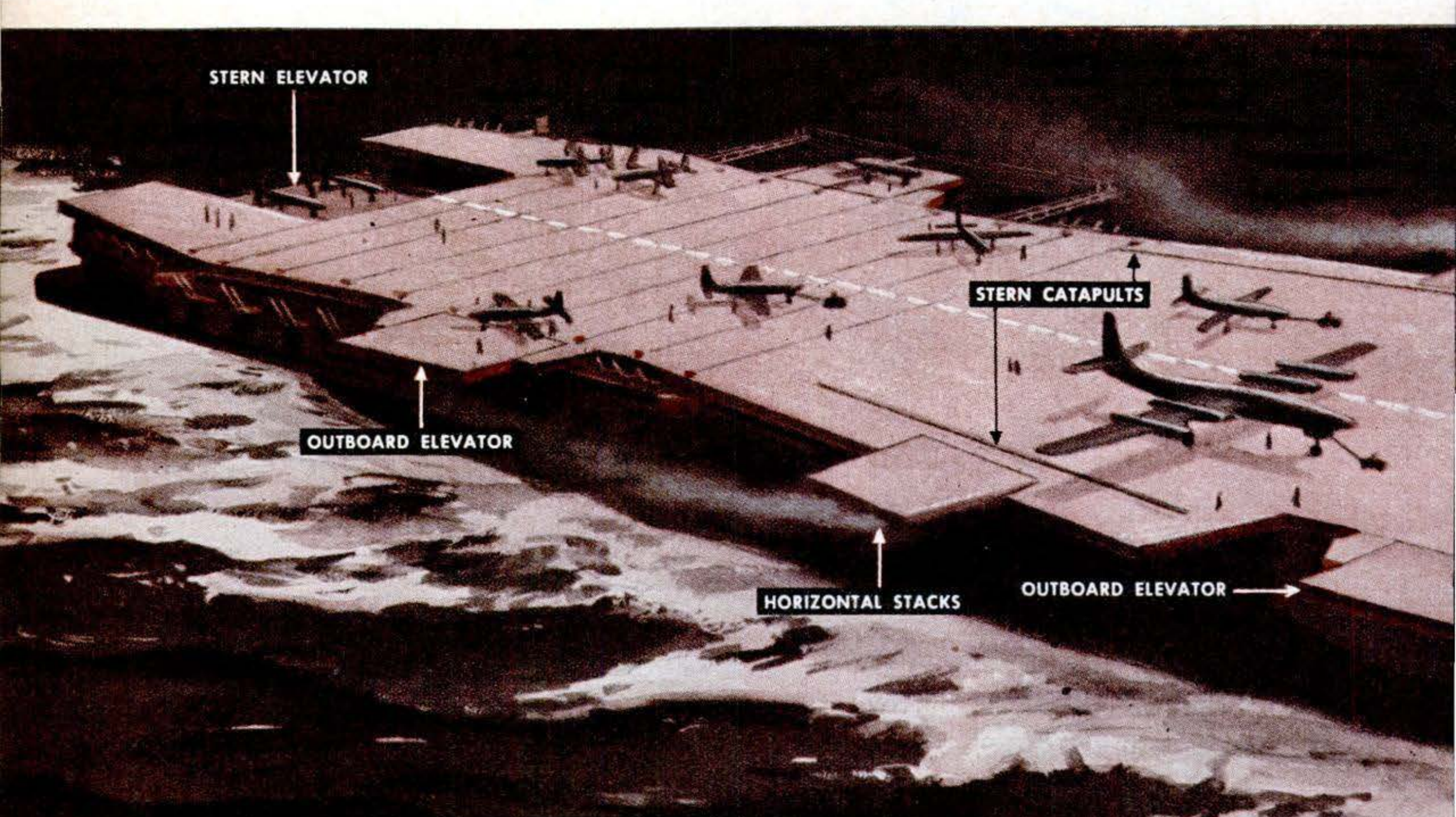
Why the Navy Wants Supercarriers

By Phil Gustafson

Drawings by Ray Pioch and Walter Popp



First flattop ever designed from scratch for jet bombers, the new 65,000-ton CVA-58 will carry planes nearly as big as B-29s, says the Navy. They could drop the A-bomb, pin-point vital targets, stage "airphibious" infantry from nearby bases, or put ashore helicopters full of Marines. The islandless flight deck provides a five-acre airfield nearly a fifth of a mile long. Four catapults, served by five deck-edge elevators, will speed launching of planes.

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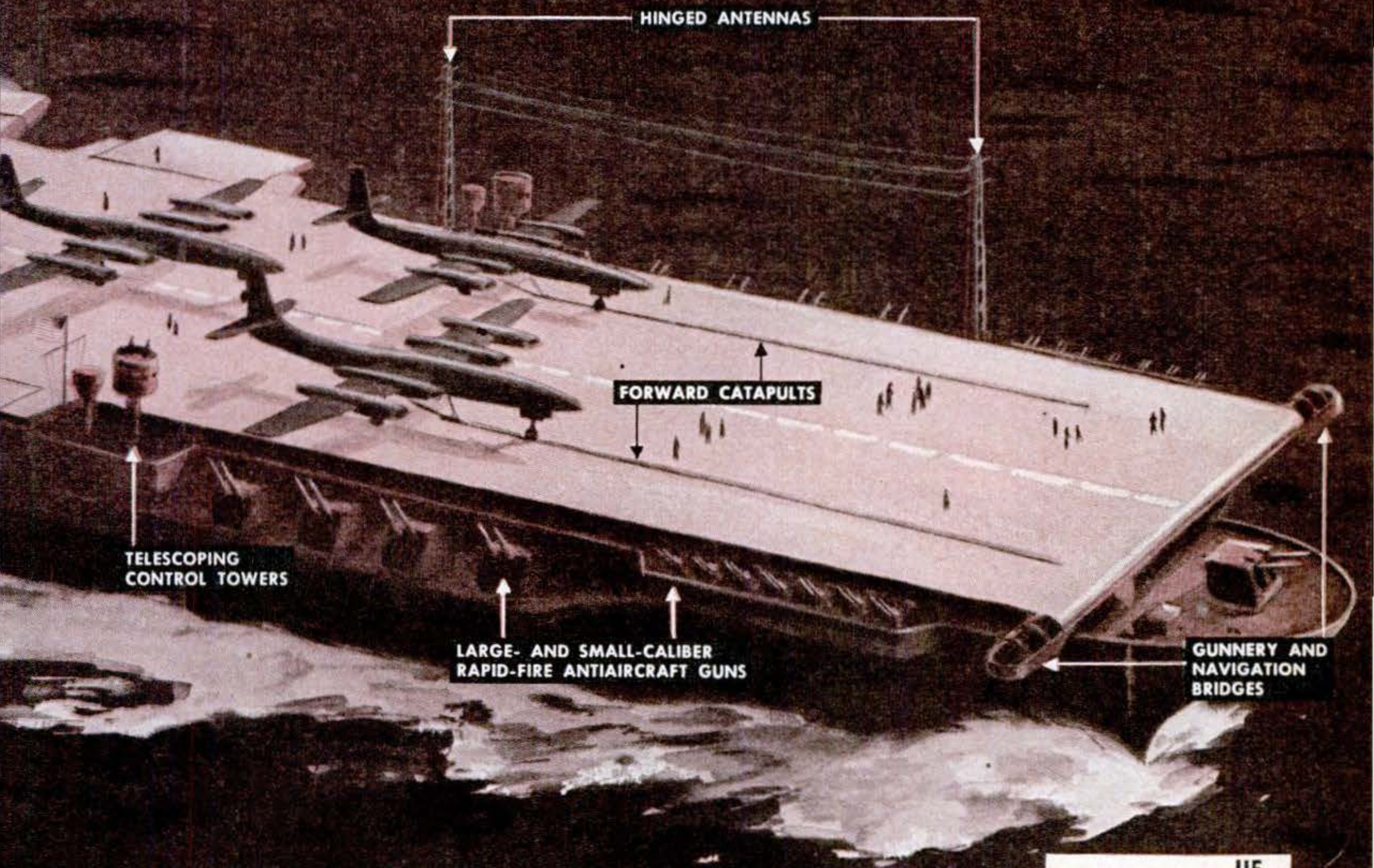
Jet planes, and bigger planes, call for a fresh start in carrier design as well as bigger ships.

EARLY this year, the keel will be laid for a $124,000,000 super aircraft carrier. Prototype of a 65,000-ton class, the CVA-58 will be *two and a half times as big* as the 27,000-ton Essex class that gave the Japanese navy the business.

Here is a flattop that is really a flattop. The island structure has been shorn away completely. A flight deck nearly a fifth of a mile long is expected to launch planes of any shape and size the Navy may bring out in the next 20 years.

The supercarrier can be interpreted as the Navy's bid to lug the A-bomb. But the big reason for ships of such size is the coming of the jet airplane.



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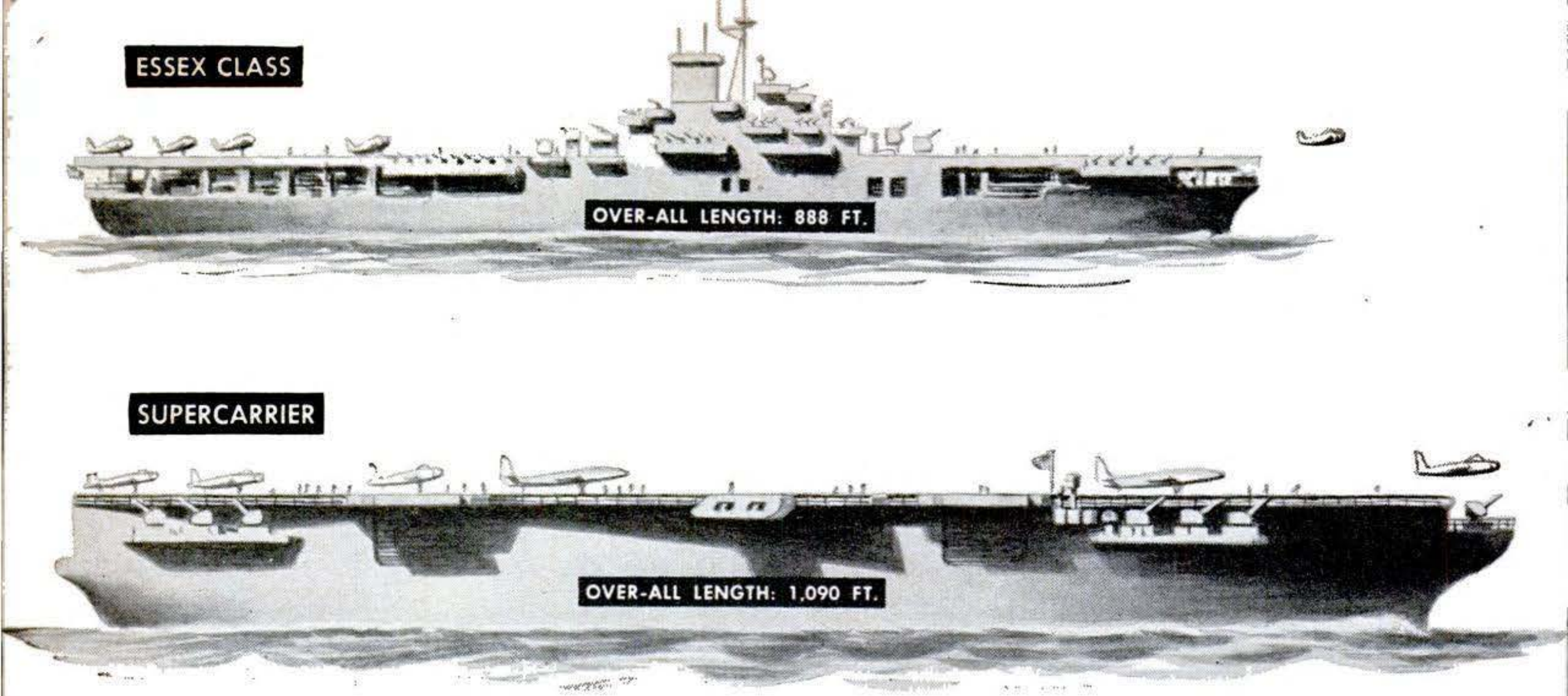


A truly flat-topped flattop, supercarrier CVA-58 will have flush deck a fifth of a mile long.

"Here is a fresh start in fast-carrier design," says Rear Admiral John H. Cassady, Assistant Chief of Naval Operations for Air, whose special job has been to help develop the new flattop. "It is the first of the Navy's carriers to be built from scratch with jet planes in mind. And not only jet planes, but jet planes of a size not yet even on the drafting boards."

Eventually, say the Navy's air-operations officers, these planes will be jet bombers almost the size of the present B-29s and two or three times as fast. Weighing almost 100,000 pounds, they are expected to take off from their seagoing airdromes 1,000 miles from an enemy's coast and fly as much as 700 miles inland to hit their objectives. Compared with this performance, today's carrier planes are mere June bugs of 20,000 pounds, with a combat radius that only recently has reached 700 miles.

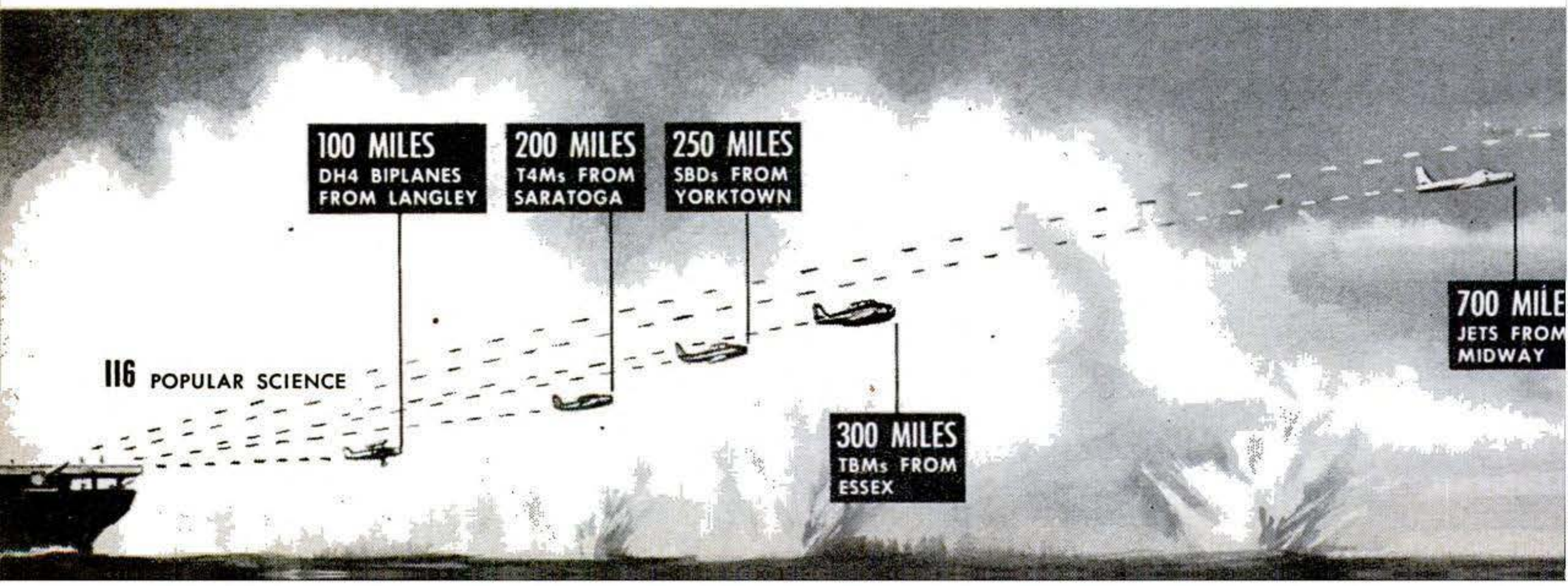
"We're thinking about a plane with a combat radius of 1,700 miles right now," Admiral Cassady told me. "It should be coming out in 1952 or '53, about the time the new carrier is completed. This ship is mighty important; without it the evolution of the fast carrier will be seriously delayed."

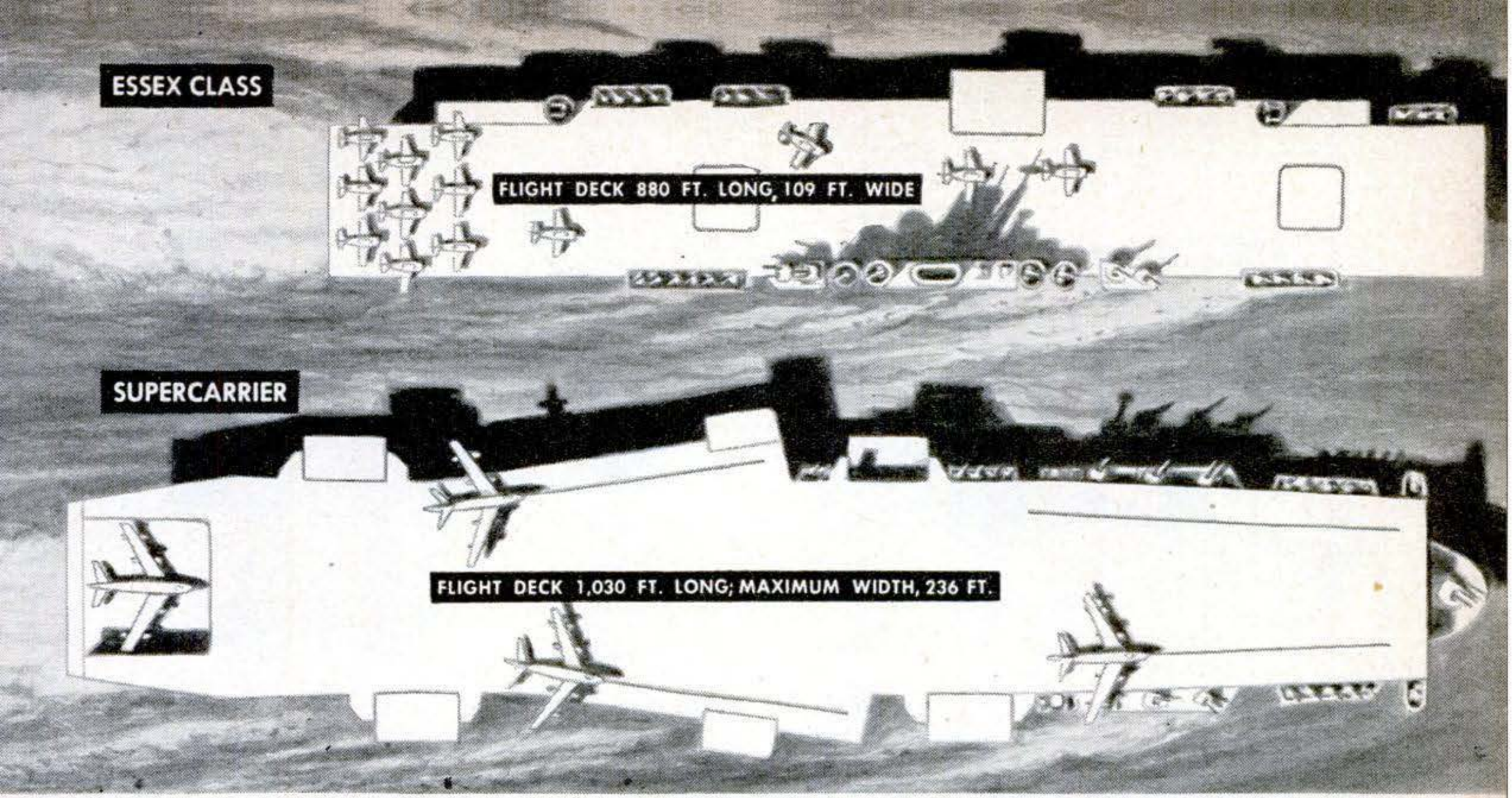
The flush deck is but part of the new look that has been coming over carriers since the first time a jet plane sat down on one.

The carrier has been an airfield built around a type of plane with a wicked fan on the nose but only a fishtail in the rear. Now you have a plane with two very dangerous ends—a treacherous suction front and a very hot behind. When a jet engine whines up to shrieking speed, you give the airplane deck space—and lots of it.

The carrier has been a football field with charging lines of plane pushers. Today a tractor replaces the muscle mob.

The carrier has been a floating garage, built around a complicated plane engine that takes a lot of elaborate service. When something goes seriously haywire in jets, you'll





The Navy's speedy new floating airdrome will more than double the size of carrier airfields.

probably replace the engine with a new one.

The carrier has been just a ship, with a row of stacks on deck, and conventional aircraft have finagled their way around the obstructions as best they could. The plane with the piston engine can keep wiggling into position until it hits the apron. With jets, it's a straighter shot. And a costly waste of fuel, going all the way around the circle again, in case you get a wave-off.

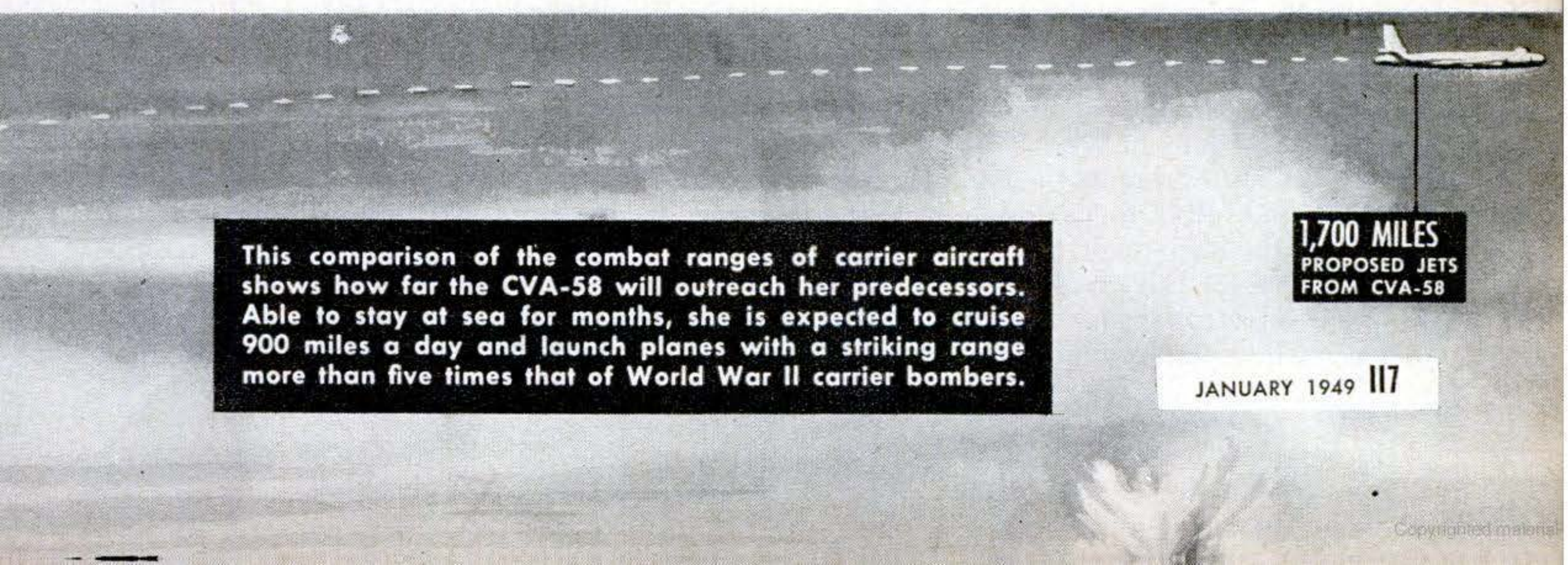
It all adds up to a need for unobstructed space on the flight deck—and a lot more of it. Jets mean new handling and servicing techniques, new equipment, and new procedures all around.

To those who think of the present 45,000-ton Midway class as the carrier of the future, the Navy explains that, as jet planes grow in size, range, and speed, even the Midway carriers will eventually become obsolete. They represent an outgrowth of wartime experience and the grafting of one enlargement after another upon a hull that began at only about a third of its present size.

In the first place, the *Midway* has all too little space on the flight deck for the handling of big planes. Her airstrip is only 132 feet at its widest point and only 932 feet in length. Counting the obstruction of the island, only about 100,000 square feet are left in which to trundle planes around.

Compared with this, the flight deck of the new CVA-58 measures 236 feet at the widest point and 1,030 feet in length. This gives more than 200,000 square feet of space in which planes can be moved about freely. In fact, the flight deck of the new carrier will be so huge that an Army-Navy football game could be played at one end while a Rose Bowl game was going on at the other.

And even the armored flight decks of the *Midway* are not strong enough to take the pounding of future airplanes—impacts that are the product of their great weights and speeds. The CVA-58's deck will be stressed



This comparison of the combat ranges of carrier aircraft shows how far the CVA-58 will outreach her predecessors. Able to stay at sea for months, she is expected to cruise 900 miles a day and launch planes with a striking range more than five times that of World War II carrier bombers.

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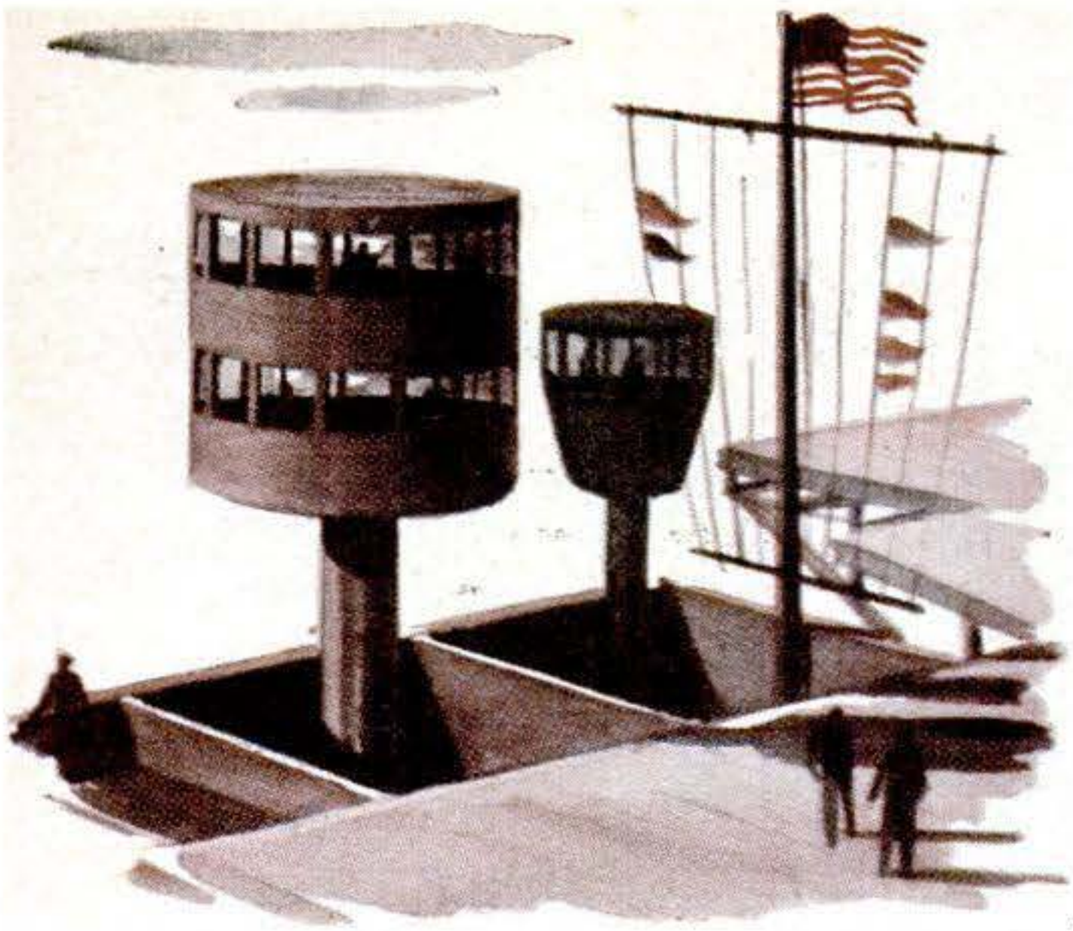
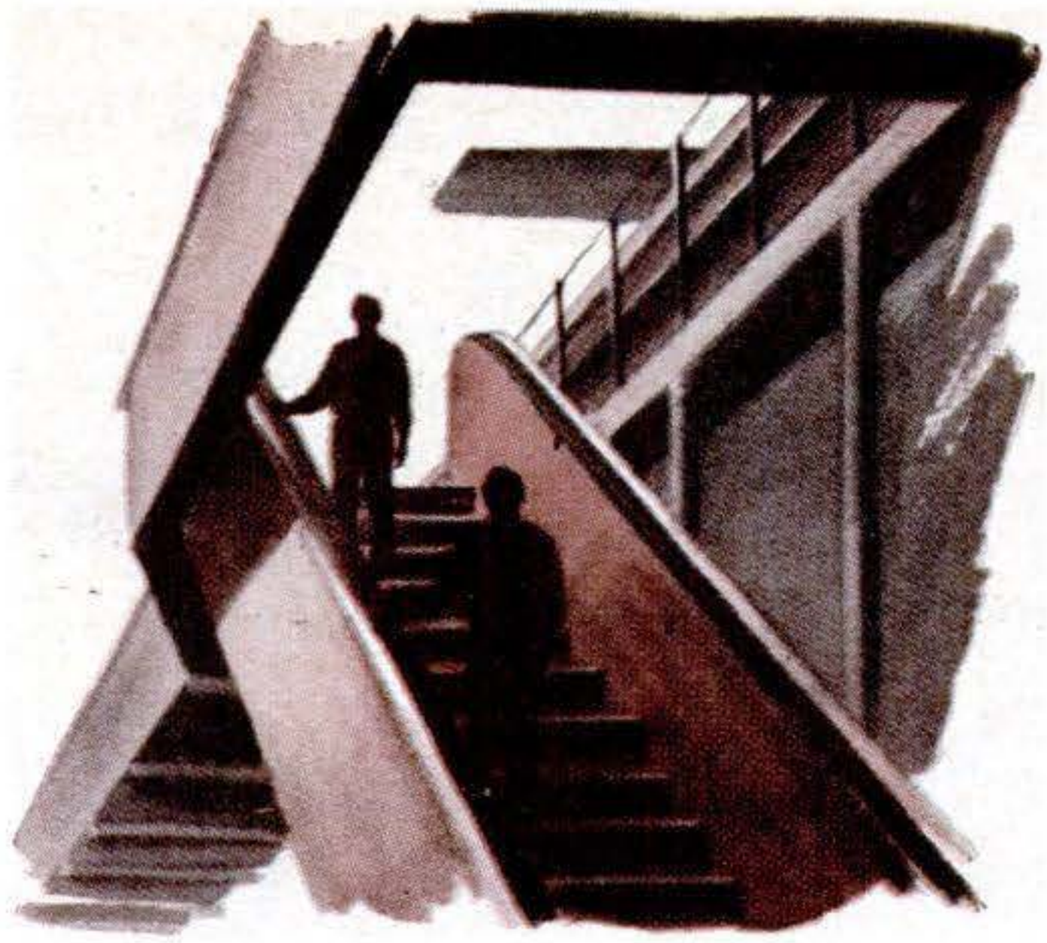


Telescoping bridges for captain, admiral, and air officers will come up alongside flight deck.



Escalators will carry pilots and crewmen to their planes on CVA-58's expanse of runways.

to stand landing wallops of 500,000 pounds. Centerline elevators further weaken the *Midway's* deck. The new deck will be all of a piece, with the elevators at the edge.

But why not reconvert the *Midway* to provide a flight deck of greater size and strength? It's a losing game, say ship designers, because the weight and size of the *Midway's* decks are already near the maximum for her hull. In the new carrier, a broad beam of 130 feet at the waterline will balance the bigger deck. In the *Midway*, the waterline beam is only 113 feet, while in the Essex class it falls to a bare 93. The *Langley* hull, with which carriers began, was only 65 feet in the beam.

But if it's flight-deck space that's needed, why not sheer off the *Midway's* island? It can't be done, ship architects reply, without extensive changes in the ship design itself. For one thing, you'd have to rebalance the hull by shifting fuel tanks and other large compartments. The CVA-58 will begin with these changes, plus enlarged fuel tanks and ammunition stores to serve the bigger planes. More armor, more armament, new types of equipment—all these and a hundred bright new ideas, not to mention living facilities for a small city of 4,000 crew members, will tax even this mammoth hull.

The CVA-58 represents the end of a cycle in the rise and fall of the island, a cycle that began with the flush deck of the old *Langley* in 1922. In succeeding carriers, compartment was piled on compartment—a radar center, a place for flag plot, a communications center, and what was that thing the fellow thought up yesterday? Things reached a peak early in the war, when the island of the Essex carriers became so complex that on dark nights the captain needed a guide to find his way to the bridge.

What Went Up Must Go Down

Then, on succeeding carriers, piece after piece of this complicated equipment was transplanted below deck—much of it to the new combat information center down in the core of the ship. And on the new carrier, all that remains topside are observation posts from which the captain and his assistants can handle the ship in close combat, bring her in to dock, send signals visually, and direct planes on deck.

All this will be done from small telescopic bridges on the edge of the flight deck about a quarter of the way back from the bow. The captain will have one to starboard and the flag admiral one to port. The air officers will have similar bridges nearby. All four of the new bridges can duck down below the flight-deck level when planes are taking off, probably going up and down on hydraulically operated posts. Fixed control bridges on the fore corners of the flight deck will house navigation and gunnery officers.

As designs stand today, the stacks of the new carrier are horizontal, built into the flight-deck structure about two-thirds of the way aft. Radar and communications masts will be extended horizontally off the edge of the flight deck and hinged so that they can

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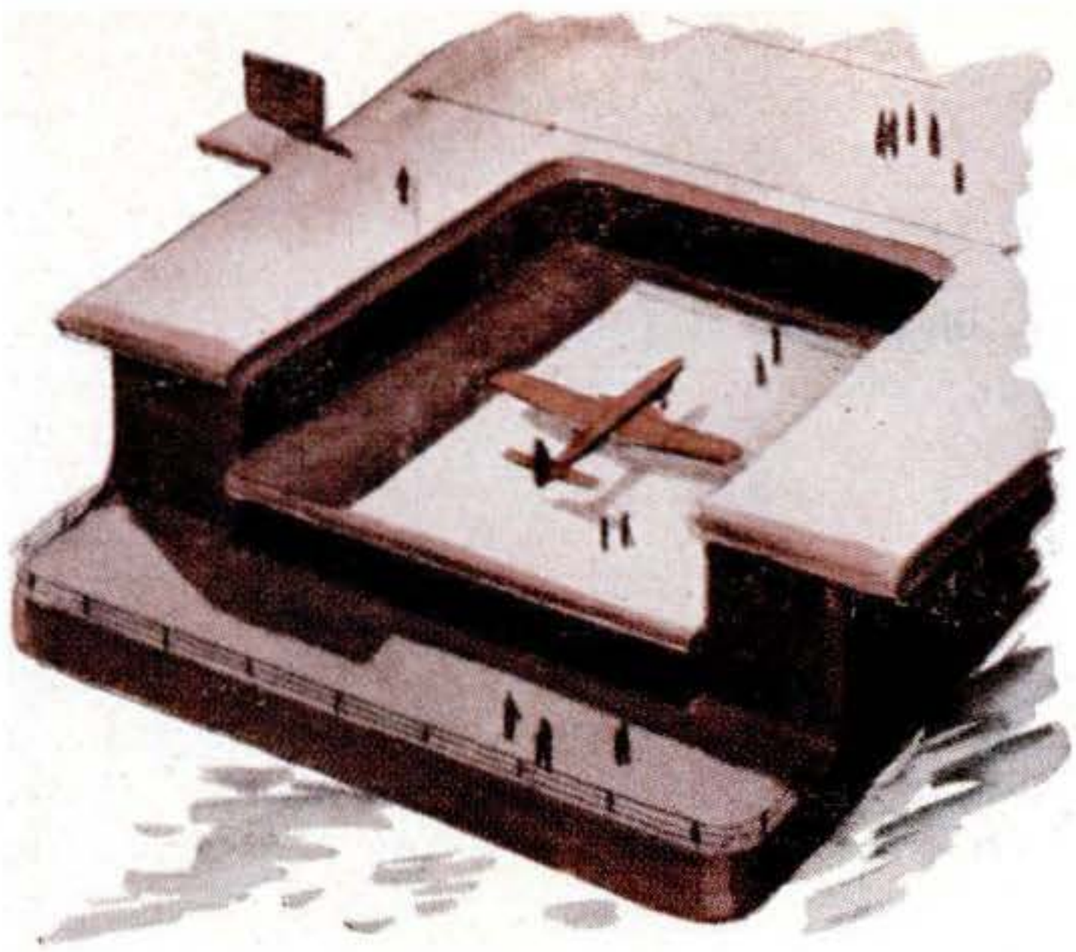
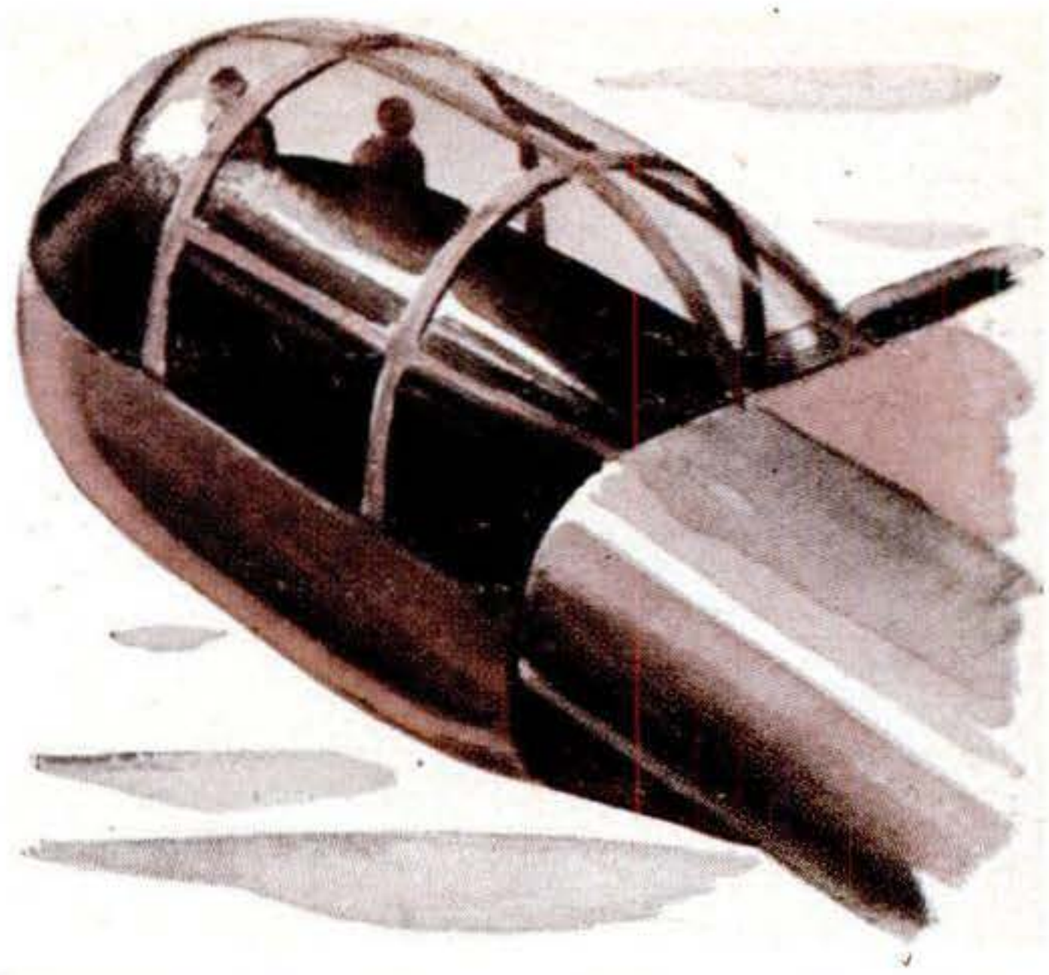


Huge stern elevator will bring up planes for launching. Four others are placed outboard.



Gunnery and navigation bridges will be blisters at the forward corners of the flight deck.

be brought upright when the flight deck is not in operation.

Designers of the new carrier say she was planned to carry perhaps 30 of the biggest jet bombers with about 80 fighters sandwiched in between. Or she could handle a lot of the smaller fry—perhaps 200 jet fighters—with a speed and dispatch beyond the flight-deck officer's wildest dreams.

And she'd *better* get them off in a hurry, too, with attacks coming in faster than sound. What's more, you can't have those high-consumption jets milling around out there in the circle while you serve a cup of tea to each pilot before he takes off.

With the idea of getting them off in a hurry, four catapults have been built into the CVA-58's deck design, each served by its own deck-edge elevator to bring planes up speedily from the hangar deck below. With all four cats in action, it is believed that a couple of dozen fighters could be launched in something like five minutes—or about a quarter of the present time. Planes may even be launched and landed simultaneously. Handling of planes will be speeded up still more by a fifth elevator, on the after rim of the flight deck, to bring up a stream of planes for take-off.

On the other end of the flight, there's nothing in sight that will land planes much faster than today's optimum of one every 30 seconds. For all that's known now, arresting cables will be just newer and heavier editions of today's gear. Barriers, the fences that halt runaway planes, will have to be different for jets. In a jet, there's no engine out front to take the rap when the hook fails to catch a wire. The pilot is out front. Hence the so-called Davis barrier, designed to grab the tricycle landing gear.

More Speed, More Protection

To those who charge that carriers are sitting ducks, the Navy points out many answers in the new flattop: fighters of greater range and speed, a heavily armored ship, stronger armament, better compartmentation, speeds in excess of 33 knots. The Navy claims that no carrier was ever sunk by land-based planes, but it promises that long-range reconnaissance planes with high-power radar will improve future protection by allowing even earlier interception. Some of this protection may come from special support carriers operating fighter planes and ranging at great distances. For the most part, the big flattops will probably stick to carrying long-range bombers.

Among their hottest targets would be enemy submarine building facilities, supply yards, and operating bases. As the Navy sees it, a fast-carrier task force, with the CVA-58 as its nucleus, could strike on an hour's notice, sending in fast precision bombers to close the mouths of the enemy's submarine pens before he even knew what had hit him. Others might drop A-bombs on his sub factories and bases, contaminating them indefinitely. Cut off support from enemy underwater fleets while they are at sea, say anti-submarine warfare officers, and

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they'll die on the vine within three weeks.

Whatever its mission—lone-wolf strike or sustained attack on enemy airfields in support of a landing—the fast-carrier task force of tomorrow must work from far at sea. The speed and range of the modern interceptor have driven it off the coast. This is one key to its need for long-range planes. It has to keep its distance.

Could Launch Troop Planes

Besides protecting the ship-to-shore forces, the new carriers may launch planes that carry troops of their own. "Airphibious" troops, you might call them—paratroopers staged from nearby bases in transports that would land on the CVA-58 for their last supply of gas. Then they'd take off and drop their passengers behind enemy lines to disrupt communications and work other kinds of mischief ahead of landing forces.

The Marines have already landed an entire command post with carrier-based helicopters. They could use the new carrier's decks as a base from which to put ashore advance contingents of all kinds—hospital corps, sabotage teams, or observation squads —with large troop-carrying helicopters.

Besides these offensive functions, the big carrier will have important defensive chores. Herself able to steam nearly 900 miles a day and launch 1,700-mile planes, she could very well scan half an ocean at a time. Two such carriers, in concert with smaller ships, say Navy communications experts, could set up an air-observation umbrella over the whole Atlantic or Pacific. With long-range radar on ship and plane, it would be possible, they say, to "see" from San Francisco to Paramushiro. No excuse for another Pearl Harbor then.

Carrier task forces in mid-ocean might be used to shoot down jet attackers, or even guided missiles. Task forces on guard duty in far corners of the world might crack down on new air bases set up for surprise attack. No important target on any continent, the Navy likes to point out, is farther than 1,700 miles from a year-round navigable sea.

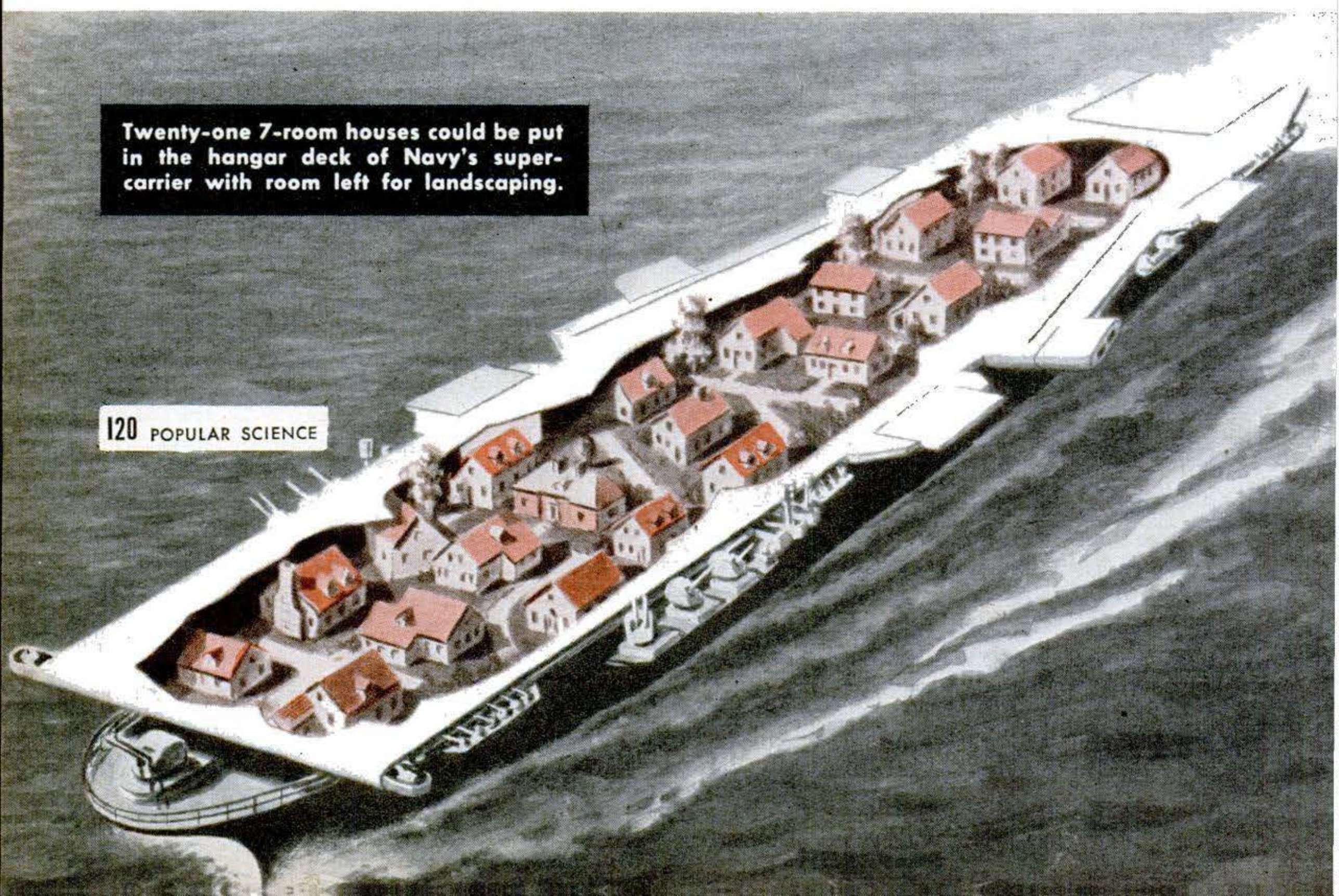
So range is the key to the new carrier.

Able to stay at sea for months, cruise nearly a thousand miles a day, and strike out 1,700 miles by air from an unknown quarter, the new carrier is visualized by the Navy as an advance airdrome that will be practically global.

An airdrome that can hit *and* run. END

Cold vs. Warm Water

A SHIP loaded in winter at a northern port will sink lower in the water as it enters tropical seas. That's because cold water, being more dense than warm water, is also more buoyant. For the same reason, a ship will ride higher in salt water than in fresh water.



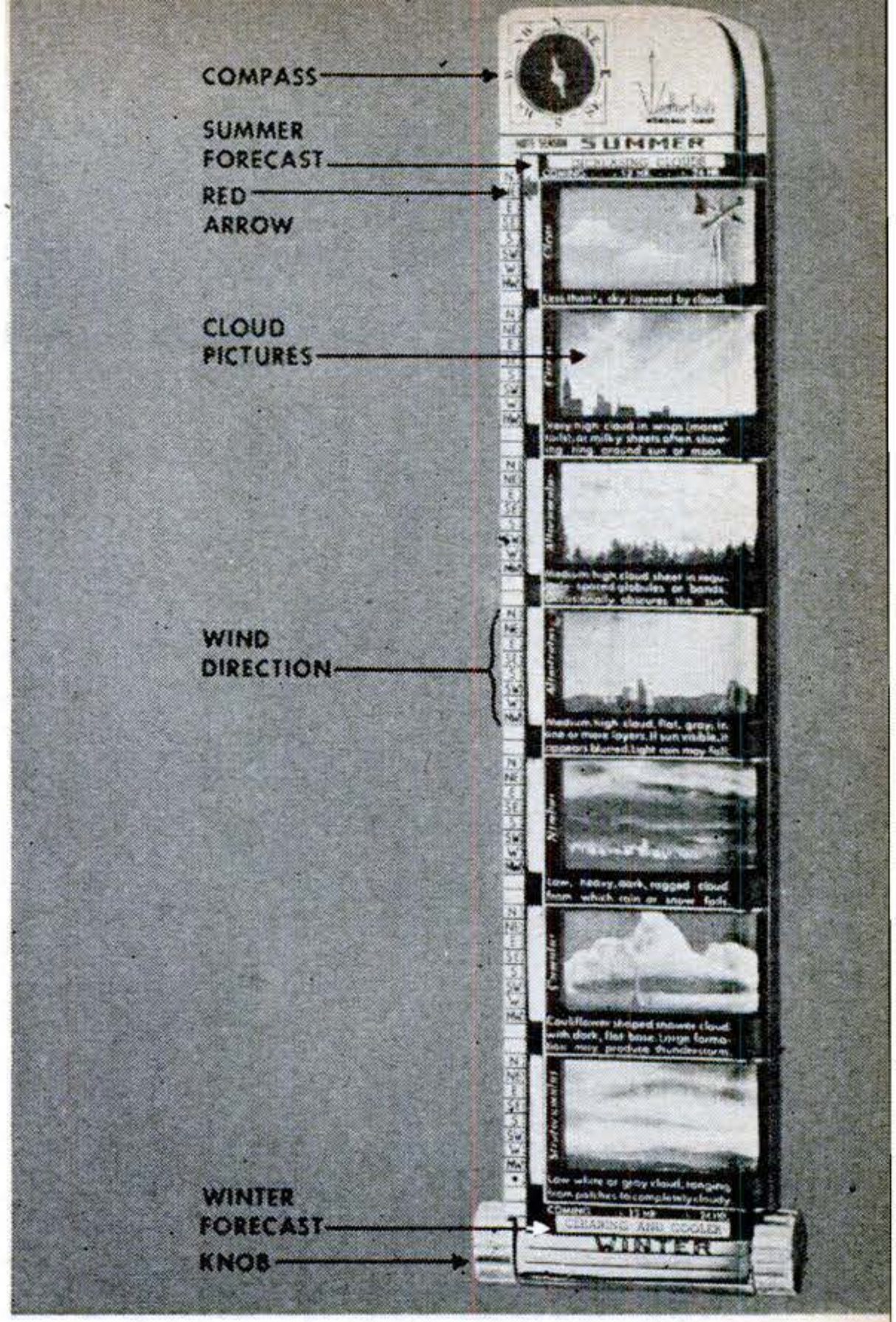
Twenty-one 7-room houses could be put in the hangar deck of Navy's super-carrier with room left for landscaping.

Pocket Machine Forecasts Weather

You can dial the weather with a new pocket-size predicting machine, shown at right, that figures out forecasts from wind and cloud conditions.

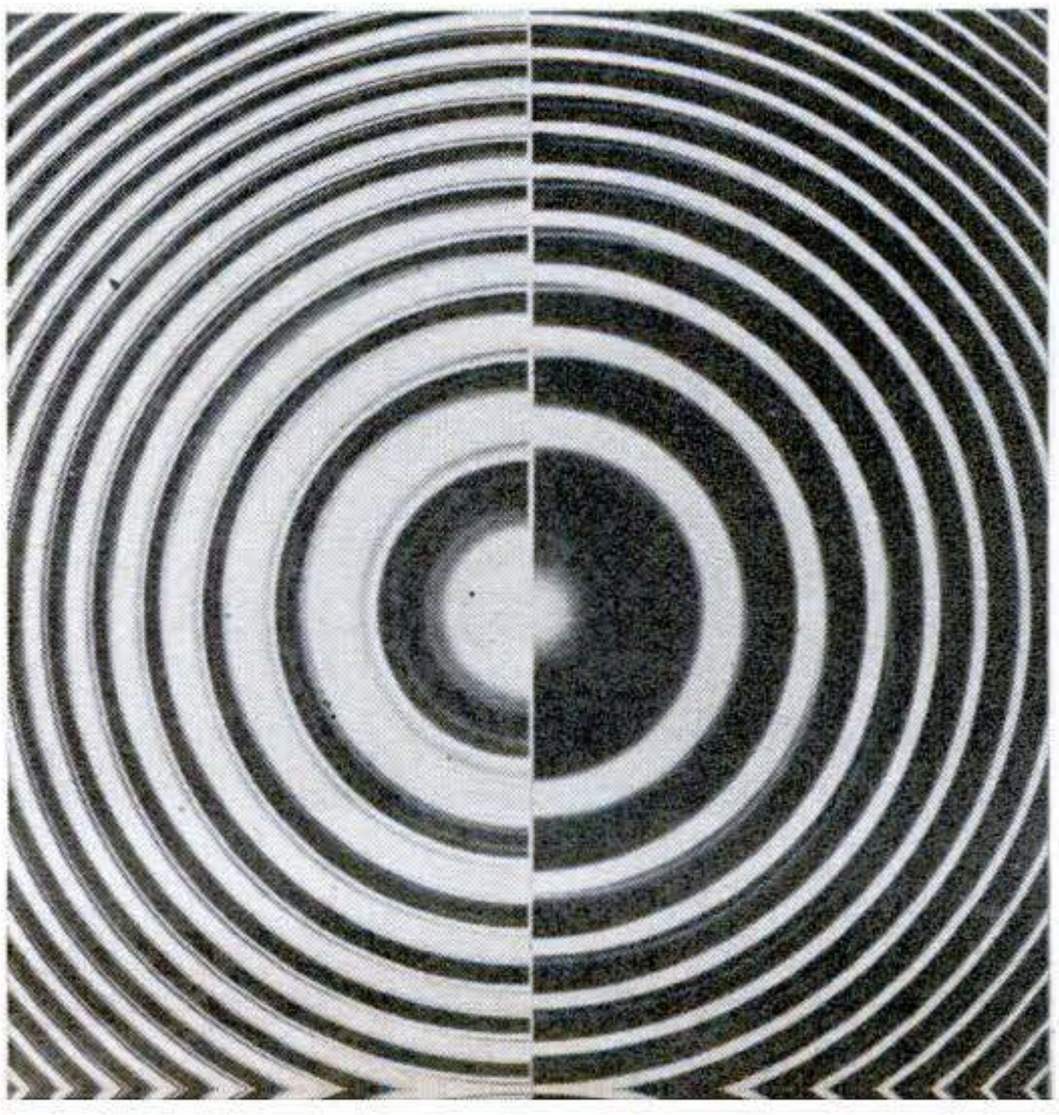
To operate the Weather Guide®, you first note the wind direction, using the compass built into the forecaster. Next pick from the seven color pictures on the face of the machine the one that looks most like the clouds you can actually see in the sky. Then turn the knob at the bottom until a small red arrow lines up with the correct wind direction alongside the cloud picture you selected. The weather prediction for the next 12 to 24 hours then appears in one of two little windows—the top window for summer, the bottom one for winter. All the possible predictions are printed on a belt that moves under the pictures.

Dr. Irving P. Krick, of Pasadena, Calif., figured out the device after studying a 50-year collection of Weather Bureau records to learn how weather was related to wind direction and cloud formations. The Weather Guide sells for $12.50.



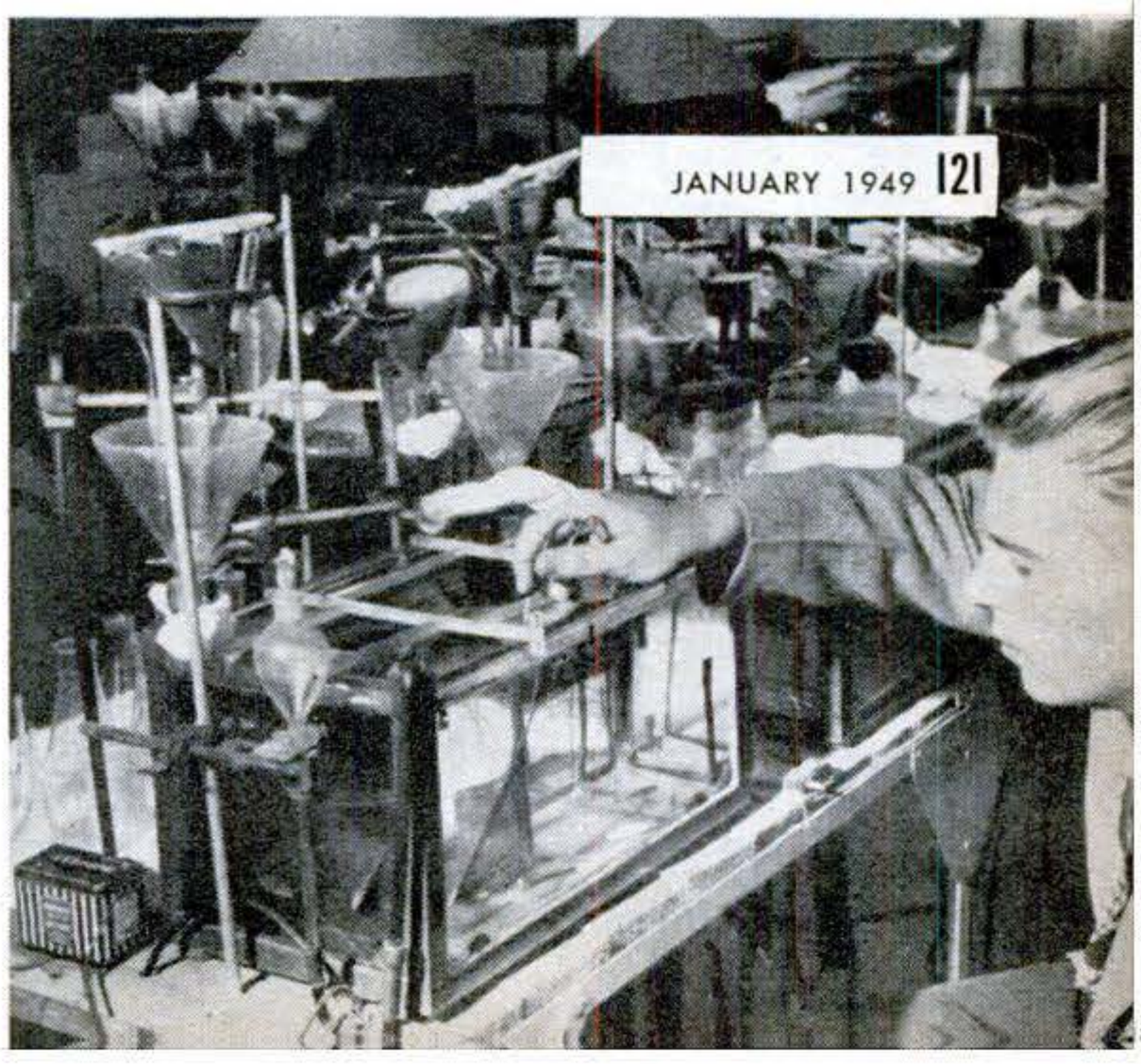
World's Best Yardstick

The world's most precise measuring stick shows its stuff in the prize-winning photograph below. The picture, taken by Dr. William F. Meggers of the National Bureau of Standards, shows interference fringes formed with light from a man-made isotope called mercury 198 (PS, July '46, p. 86). These fringes—on the right side of the picture—are so much finer than those produced with ordinary mercury—on the left side—that they permit wave-length measurements accurate to one part in 100,000,000.



Trained Fish Test Water

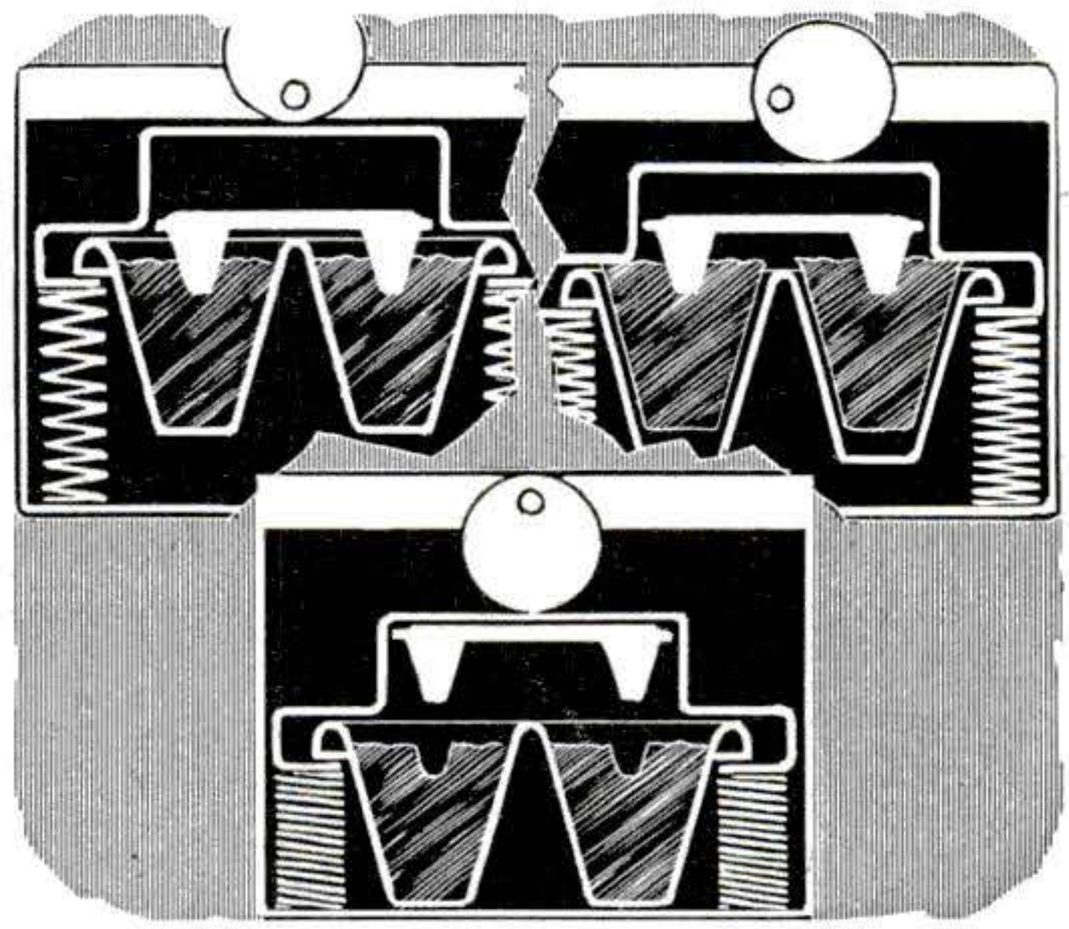
Trained minnows are sniffing contaminating chemicals in drinking water (below) at the University of Wisconsin in an experiment that may eliminate the "chlorine taste" city dwellers often complain about. The bad taste is actually caused by phenol, a chemical dumped as waste into rivers and lakes by many industries. The fish smell phenol even before it can be detected by chemical analysis, and can be trained to rush toward or away from a feeding trough at the first sniff, thus warning water-supply technicians.



New Ideas from the Inventors

Hot Spark Speeds Starting. An extra-hot spark for faster starting of cold auto engines is the object of the spark plug invented by H. Andersen, of Bayside, N. Y. A condenser around the central electrode intensifies the spark. As the engine heats up, a bimetallic disk (in circle) expands downward till it touches the electrode (dotted line). This shorts out the condenser and returns the spark to normal intensity.

Window Doubles As Mirror. You wouldn't have to fumble with that hard-to-reach, outside rear-view mirror if you had this one. It fastens to the pivoted side window and can be adjusted by simply winding the window in or out. Patented by L. Dohanian, of Somerville, Mass., it also provides a handy make-up mirror.



Ice Tray Frees Cubes. Springs hold this ice tray, invented by R. Tobey, of Springfield, Mass., up against freezing elements in the water (upper left). A crank turns a cam that pushes the tray out from under the cubes (upper right). The cubes, sticking to the freezers, are then knocked loose by the tray's downward-moving frame.

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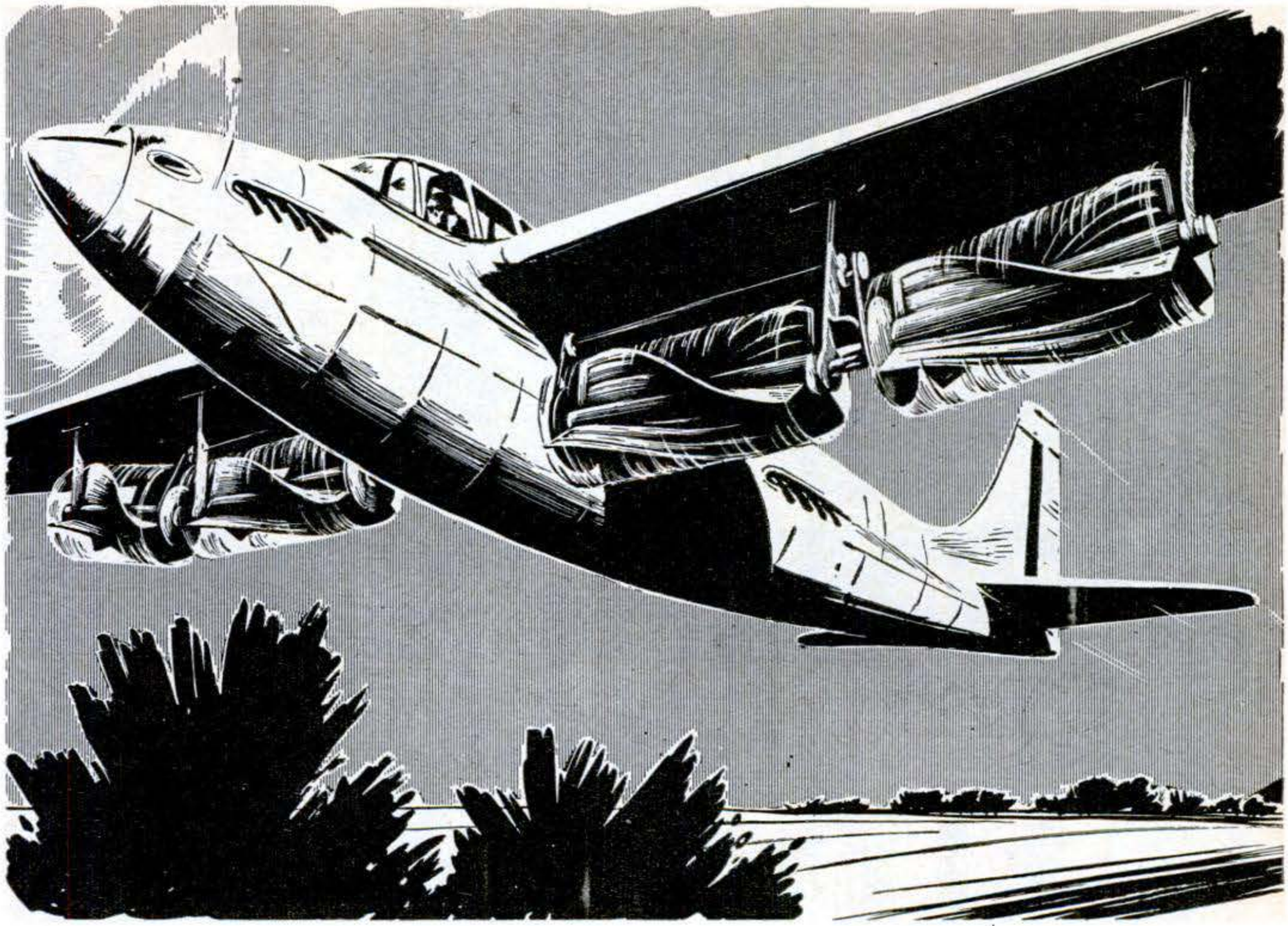
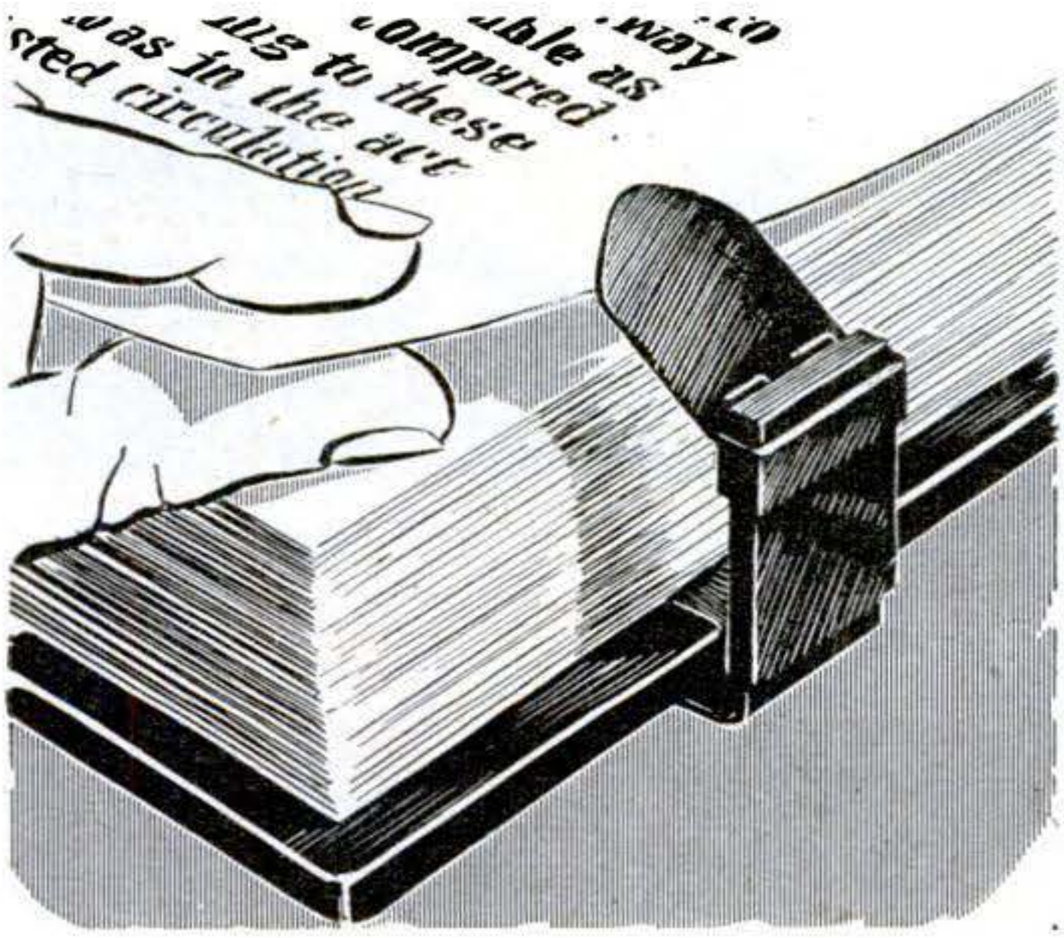
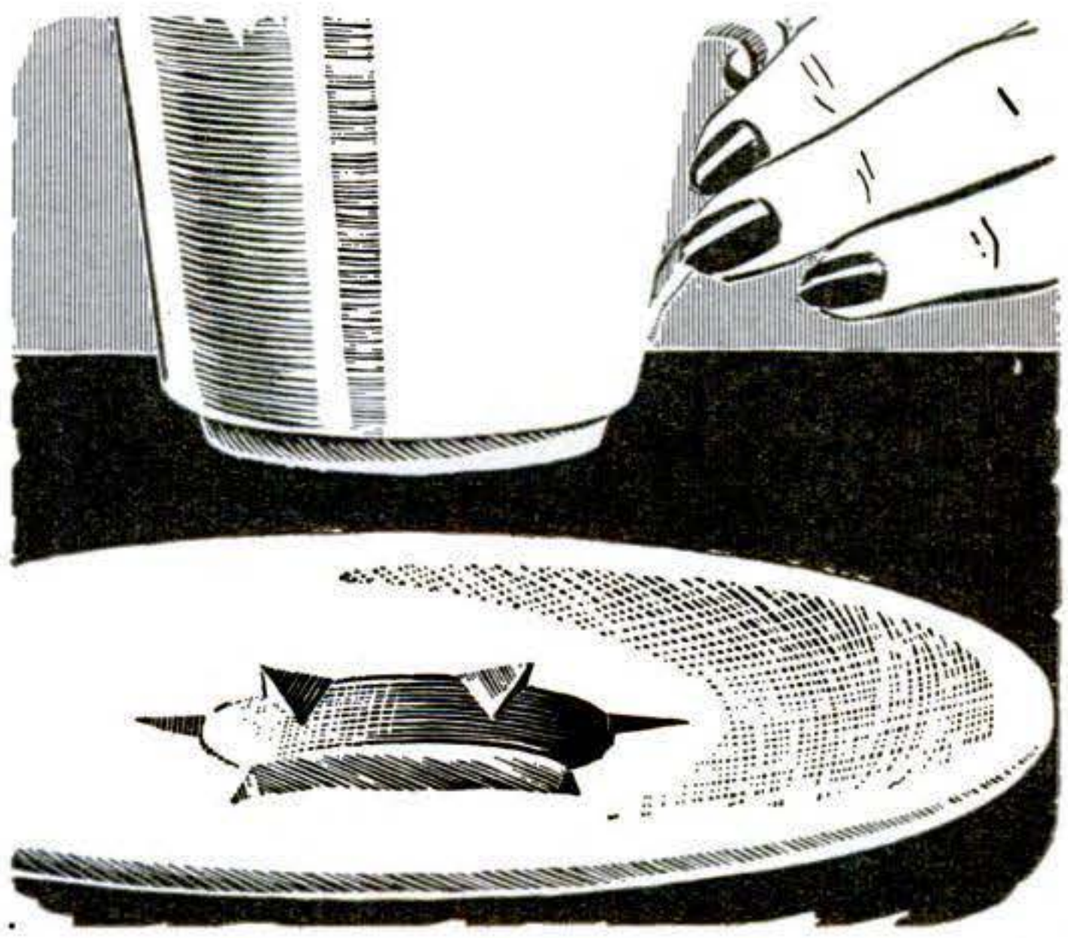


Paddle Wheels Power Plane. These lawn-mowerlike paddle wheels are designed to give added lift to help heavy planes take off from small fields. Louvers in each blade open in the up-stroke to lessen air resistance, then close in the down-stroke for maximum push. By adjusting the action of the louvers, the blades can be reset to provide tractive power for added forward speed. The inventor is D. Main, of Denver.



Book Marker Works By Itself. This automatic book marker would keep your place without your ever having to touch it. Invented by A. Safier, of Brooklyn, it clamps to the book's back cover and has a spring-hinged tab that holds the unread pages. The tab lifts up as each page is turned, then snaps back, marking the new place.



Cup Stops Slip and Slop. This novel coffee cup is kept from slipping by a flanged base that fits into a circular well in the saucer. If the coffee spills, V cuts around the well's edge let the liquid drain down out of sight and below the cup bottom so there is no drip when the cup is lifted. The inventor is W. Shefts, of New York City.

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How Strong Must We

Some partitions carry same loads as walls; others need resist only weights leaned against them or rammed into them.

Roof must carry wind and snow loads.

Walls are compressed by roof and snow above, pushed in and bulged out by wind.

Floors carry occupants and furniture, resist impact of heavy, dropped objects.

"Exploded" view of standard two-story house divides it into its structural elements.

Wind load on any given house depends on surrounding bushes, other buildings, hills, and general terrain, but the engineers figure it for a house set in the middle of a bare empty plain.

Snow load depends largely on angle of peaked roof. Above 45° it is figured that all snow slides off unless blocked by guards or gutters. But sleet will freeze to even steeper roofs.

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Build Our Houses?

Until recently, nobody really knew. Now the Bureau of Standards is replacing guesswork with test-born data for 100 kinds of houses.

By Hartley E. Howe
Drawings by Sigman-Ward

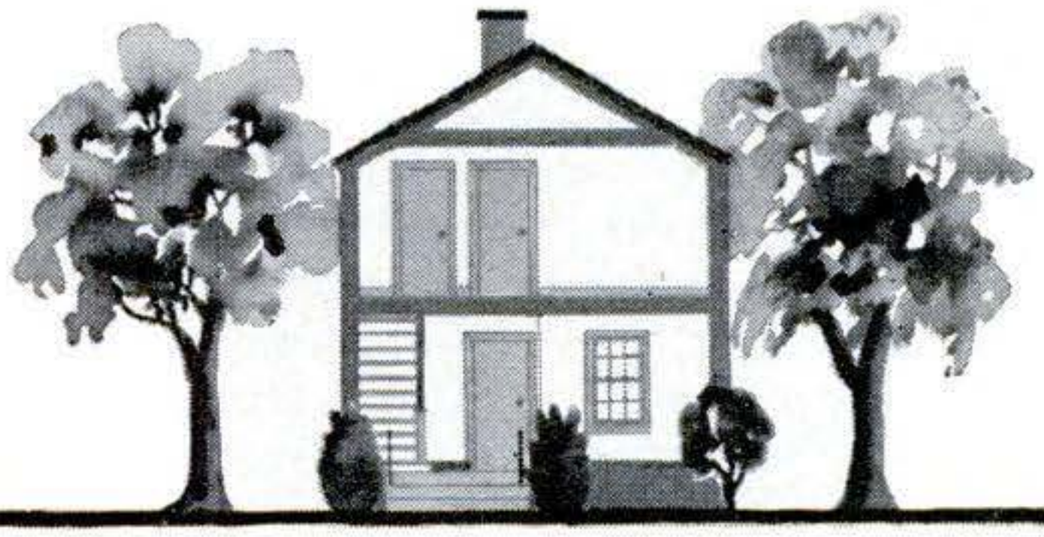
WILL your new house—when you get it—be strong enough to stand up in a storm? Maybe it will be too strong—wasting your money on a lot of wood to meet a stress it will never have to stand.

Think your architect or builder has the answer to those questions right in his pants pocket? Confidentially, he doesn't know much more about it than you do.

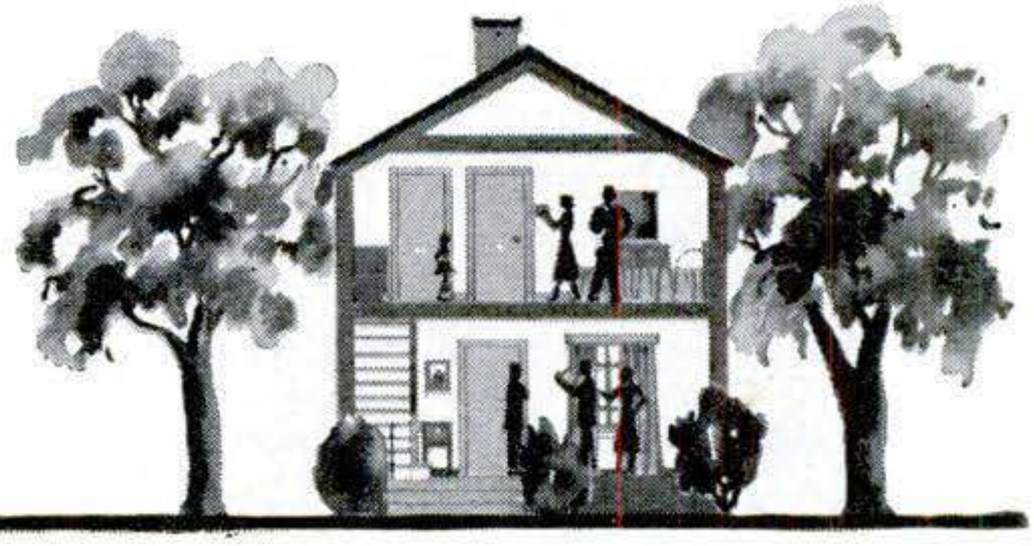
When a new dam is planned, the engineers fill a warehouse with predicted performance figures. When a skyscraper goes up, the designer can predict to an inch how much the 30th floor will sway in a 15-mile southeast wind ten years later. But building homes is still more of an art than a science, still carried on by methods worked out by trial and error and handed down for generations from master builder to apprentice.

That makes it easy to waste money by overbuilding. It makes it possible—if not very likely—to risk your family's life by underbuilding. This tradition makes it pretty difficult to judge the safety and utility of the new methods of house construction. And without data, the people who are trying to bring our building codes out of the horse-car era are working in the dark.

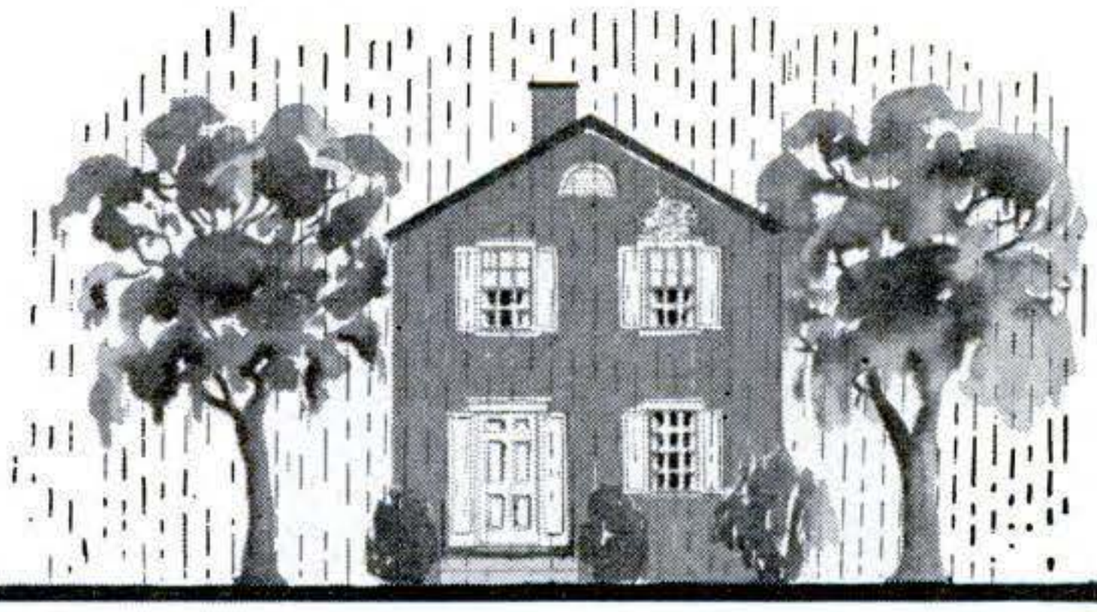
Now, however, the National Bureau of Standards is doing for homes what engineers did long since for dams and bridges—taking out the guesswork. Its research is answering two questions: How much of a load must a house stand? How much of a load



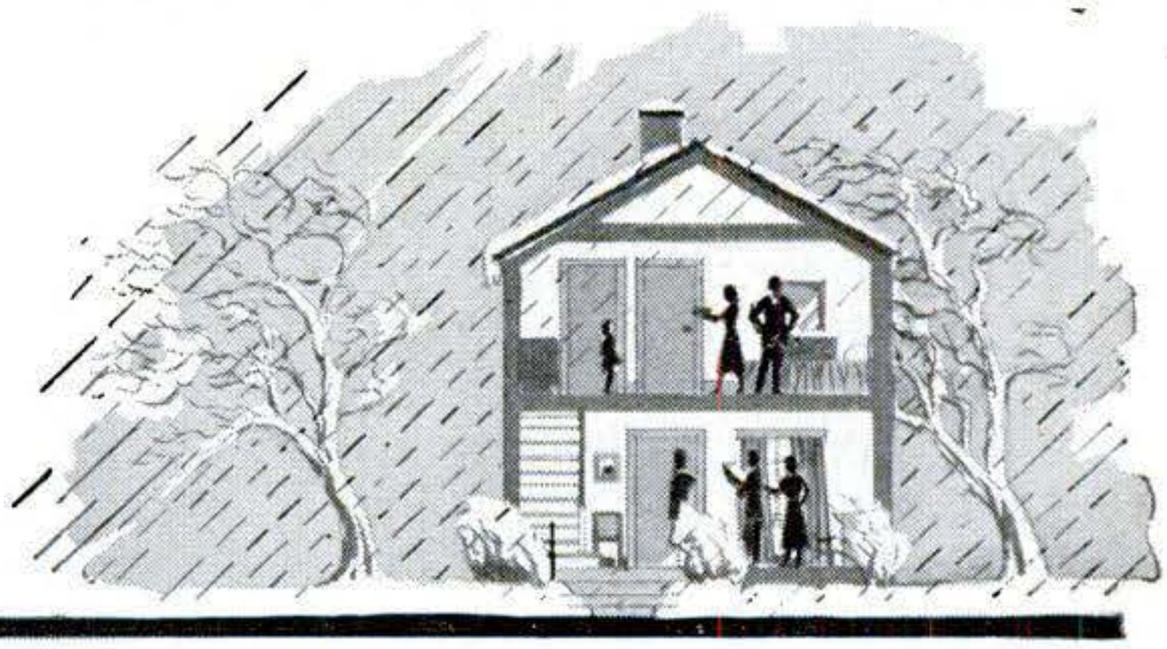
Dead load is first consideration in deciding forces house must withstand. It consists of the weight of parts of house itself, and is expressed in pounds per square foot of **face** area.



Floor load consists of the objects and people that move into the house. This varies widely, but the maximum is based on the number of people who can crowd into a room standing up.



Rain load is least important for dwelling houses, since water runs off the usual peaked roof as fast as it hits. Some modern flat-roofed houses have to allow for it in case drains clog.



Total load is figured as if all these things were happening at once. Engineers believe it may be feasible later to cut total load a house must stand to two thirds or half of total separate loads.

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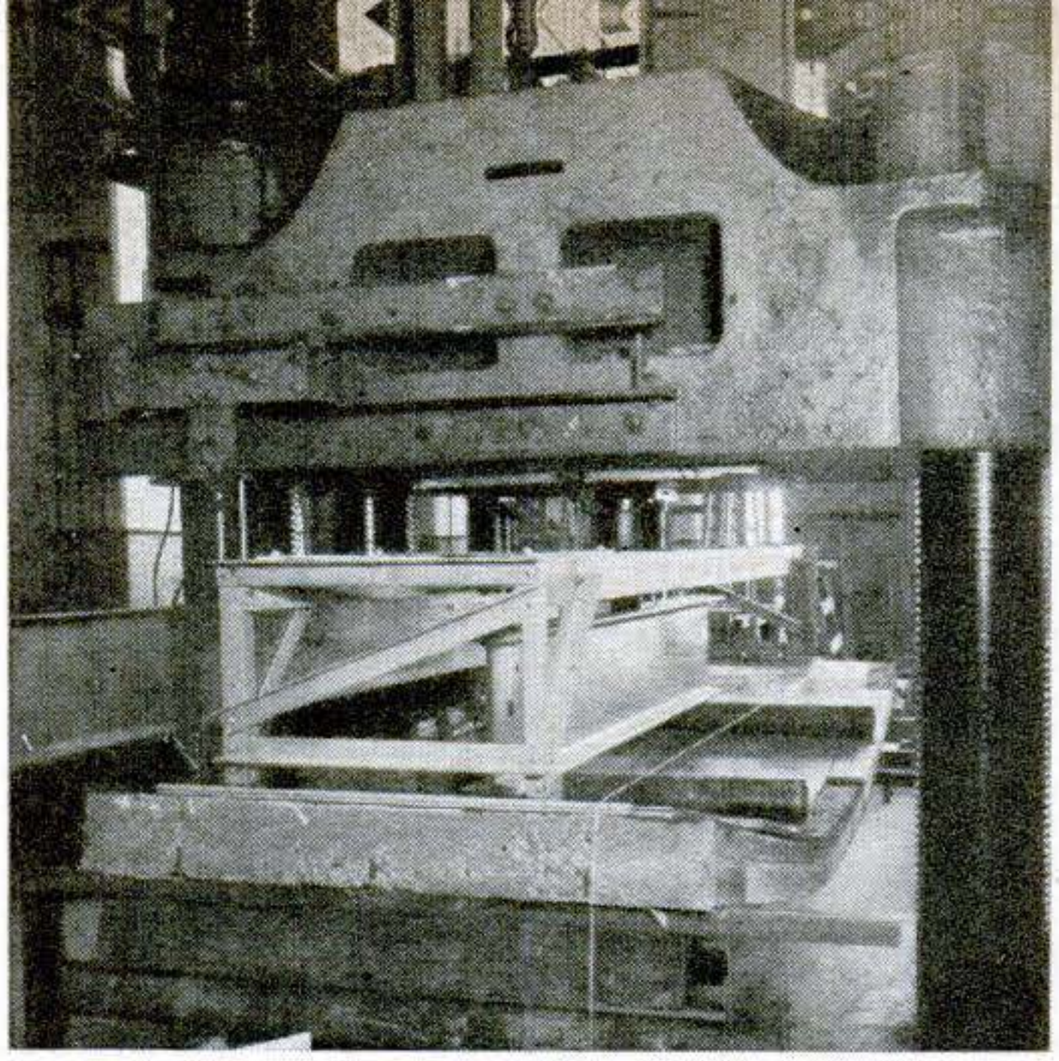
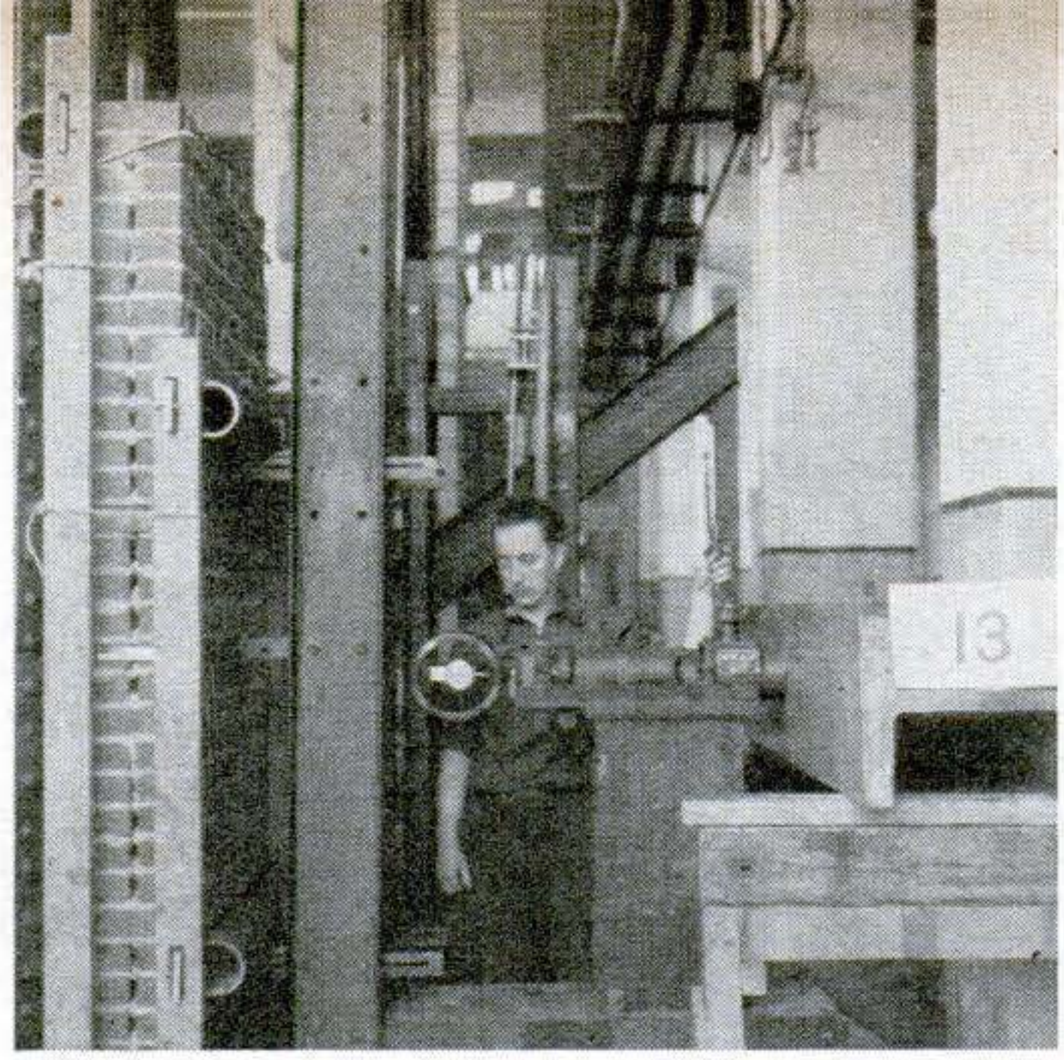


This floor has been pushed 12 inches out of line under a maximum load in 10,000,000-lb. testing machine. This test is for transverse load, caused by weight of people and furniture.



Transverse test against upright brick wall, left, represents the direct action of the wind. The big testing machine pushes at two points at once, and the amount of bending is recorded.

can different types of construction stand?

Now first results are in. They show us how to choose building methods matched to our design and our locality—and make our new houses both cheaper and safer.

Just what loads must a house stand? The answer isn't simple. When Standards engineers counted up all the pushes and pulls and bends that tear at your house, they found five different kinds.

The *dead load* comes first. This is the weight of all the parts of the house itself—roof, walls, floors, partitions. It varies greatly with different types of construction, from heavy-weight stone to bantam plywood, but it stays the same for each type. The Bureau has worked it out for each variety.

Add People and Furniture

But dead load applies only to the house itself without furniture or people. So next on our list is the *floor load:* the weight of the objects and persons who move into our empty house. A lonely spinster and a family of fifteen may live in similar houses. The engineers must strike an average. Forty pounds per square foot of floor area is about right, they figure, for a house jam-packed with people for a neighborhood party.

Of course if somebody rolls up the rugs and turns on the radio, the average load per person is going to jump 'way up. "Movement in unison"—the engineers' name for the rumba—means a heavy *impact load* and great stresses. The experts have an answer. Dancing, they optimistically figure, takes up more room per person than just standing around; so the average still holds.

The other three loads on the list come from outside the house. Ever lie in bed and listen to the rain on the roof? Or the soft thudding of snow against the window? Or the wind rattling the sashes and even shaking the house? Each of these is a load.

Not that rain is likely to prove dangerous if you have a conventional peaked roof. Snow, however, is another matter. Here geography is an all-important factor. So the Bureau has worked out a map that shows the greatest snow load you can expect in any part of the United States. Snow blows and slides off steep roofs, however, so its "k" factor—"stay-on-ness"—had to be worked out for the pitch of any given roof. This and the map's figures give your load.

The wind is the biggest bruiser of the weather loads—and the most complicated to measure. The barometric pressure, weight of air, and the wind speed will give you the pressure against an outer wall—at any given point. But it runs from zero at the bottom to the maximum at the top; so the engineers figure it for a point half-way up.

Again, the wind load not only pushes in on the side of the house toward the wind: it sucks out on the other side. And the pitch of the roof, the overhang of the eaves, and the impact angle all vary the load.

The number of doors and windows makes a difference too. This is because there is a wind load inside the house as well as outside, as a result of air leaking in around the openings. If windows break in a gale, these inside forces will rise sharply. For any house design, therefore, the windows and doors must be allowed for and the internal wind load found. This plus external load gives the combined wind load.

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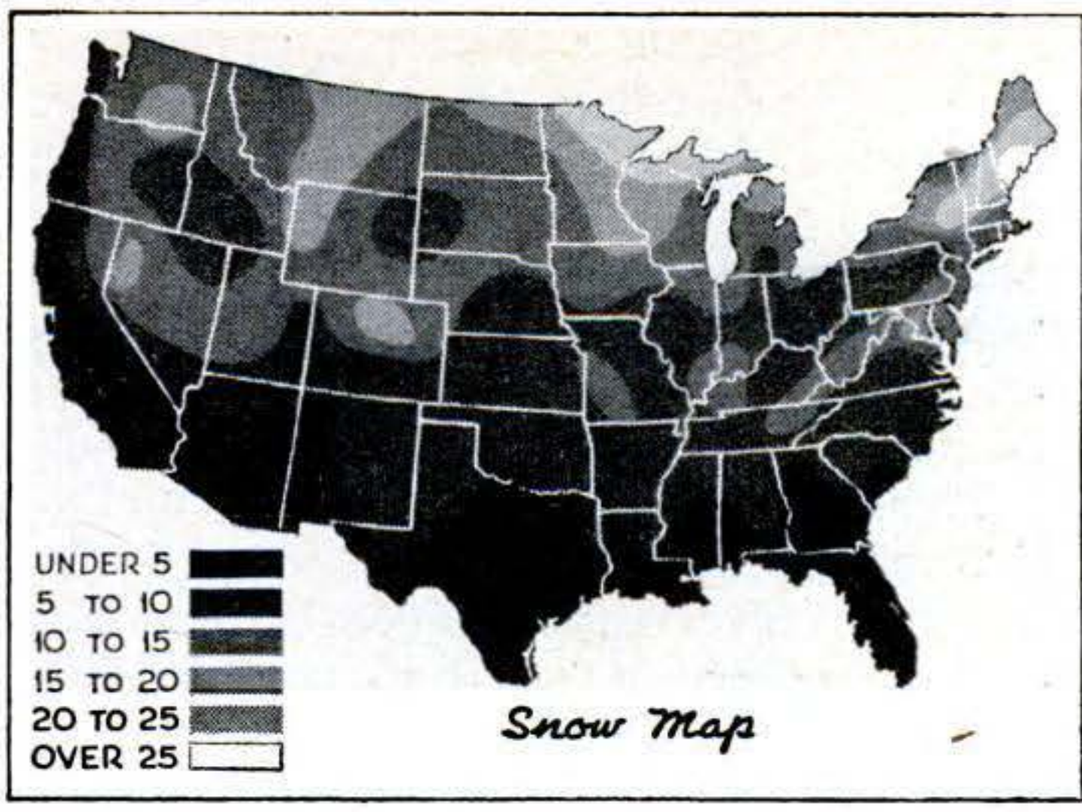
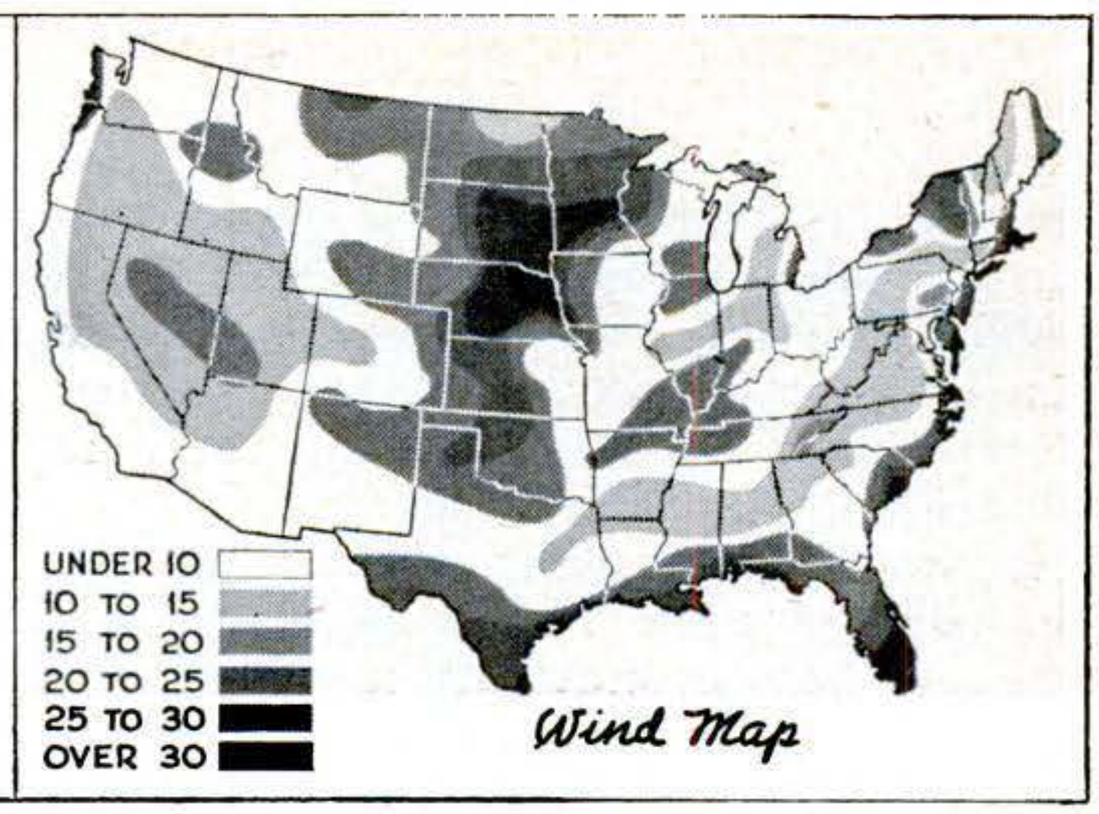


Snow map records the maximum snow load, in pounds per square foot, expected in every part of the country, based on U. S. Weather Bureau data. Loads are those on flat, sheltered ground.



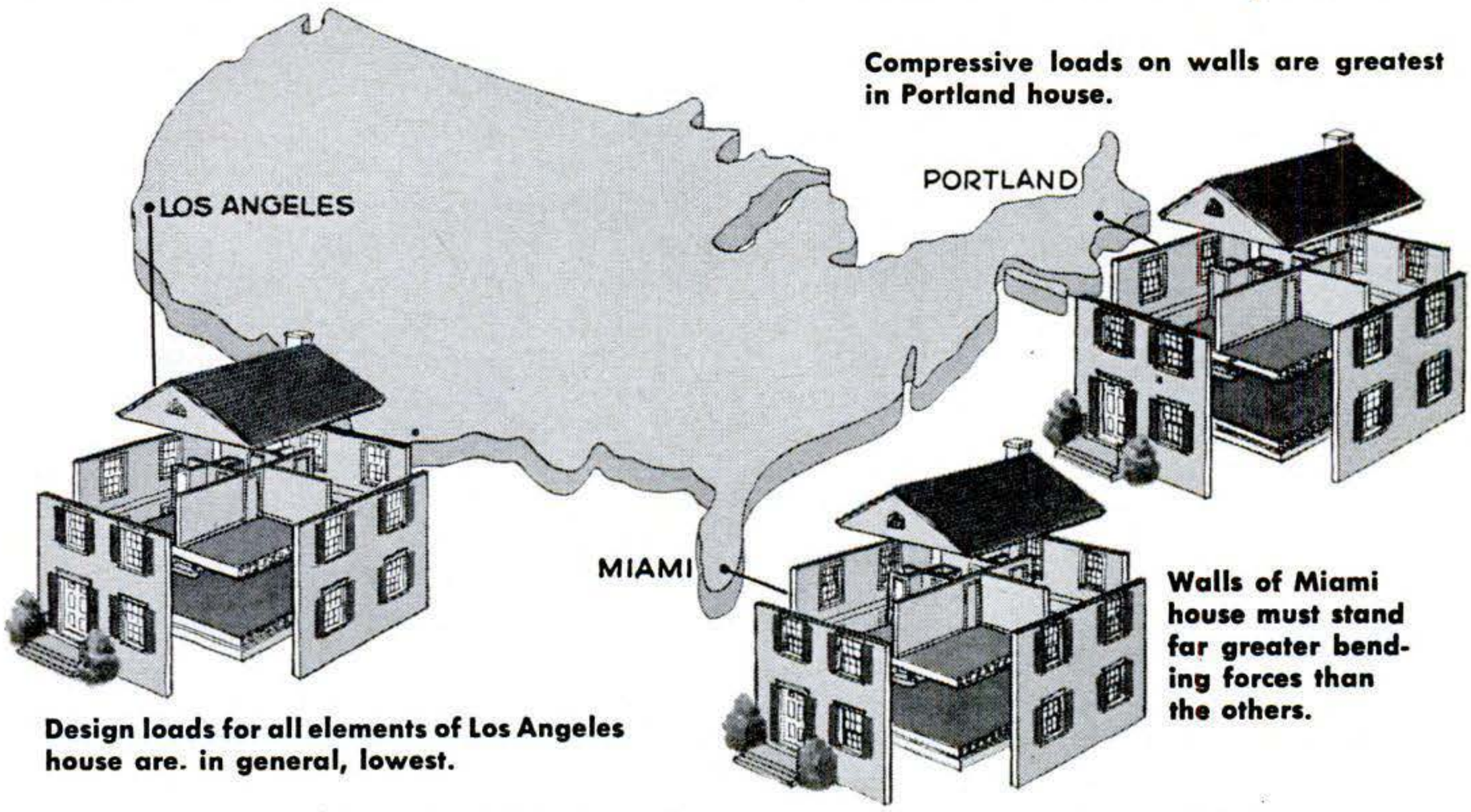
Wind map translates wind speeds into pressures, in pounds per square foot, 30 feet above ground. Highest and lowest wind-pressure regions are only 250 mi. apart on Northwest coast.

Only we don't know how much wind to expect unless we know where the house is going to be built. So the Bureau has prepared a wind map of the United States. With it the architect can apply the Bureau's formulas to his own design—and come out with the wind load his house must meet.

All this calculation gives you the separate loads on a house. And safety-conscious engineers plan on a house carrying all of them at the same time—even though they admit that it is highly unlikely that a snow storm, a hurricane, a party, and a heavy rain would all hit a house at once.

Once the loads were found, the next step was to find out just what they did to a house—each affects some parts but not others. The engineers began by "exploding" a simple house into its elements—walls, roof, floors, and partitions. The loads were figured separately for each of these elements and then totalled. The answer supplied ways to estimate the maximum load on any part of a house. This is the "design load," which a house must stand if it is to be safe to live in.

Design loads were also worked out for methods of fastening a house together—important, particularly, in keeping the roof on.



Compressive loads on walls are greatest in Portland house.

Walls of Miami house must stand far greater bending forces than the others.

Design loads for all elements of Los Angeles house are. in general, lowest.

To compare total loads in three key areas, they were figured out for a standard two-story house in Los Angeles, Miami, and Portland, Me. Wind pressure in Los Angeles was only 5 lb. per square foot, in Portland about 12 lb., but in Miami it jumped to 33 lb. Neither Los Angeles nor Miami house has a snow load, but Portland houses must stand 28 lb. per square foot.

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This answered the first question: How much of a load must a house stand? Now came the second: How much of a load can the various types of house construction carry in safety? You can't very well put a whole house under test and tear it apart; so samples of walls, roofs, floors, and partitions of 100 different types of construction were taken into the Standards lab.

Hydraulic presses pushed down on the top edge of walls for compressive loads while delicate instruments measured the amount the wall shortened and the bulges in the sides. Another press pushed walls and roofs and floors on their flat sides to see their resistance to bending or transverse loads. Screw jacks measured the resistance of walls and roofs to puncture under concentrated loads.

Sandbags Test Floors and Walls

Resistance to impact—sudden rather than sustained loads—was tested by dropping a 60-lb. sandbag on floors and walls from heights up to 10 feet. Racking loads that tend to shear a wall horizontally were imposed by fastening down the wall foot and then pushing the end with a hydraulic jack.

The result of these tests, was "the allowable load"—the safe load—for a wide variety of construction types, from standard wooden frames to precast slabs, stressed skin panels, and metal walls. If you think a wall's a wall, you should take a look at the table of results. The strongest wall under a compressive—downward—load was clay-brick reinforced with deformed steel bars. It withstood 106,000 lb. per square foot. The weakest of all under this load, a wooden frame faced with insulating fibreboard, could carry a load of only 1,620 lb. per square foot!

The variations in resistance to the other kinds of loads were almost as great, but frequently walls that did poorly on one test showed up better on another. Masonry, comparatively vulnerable to bending loads, was highly resistant to compressive loads.

Roofs showed an equal variety. The strongest—wooden frames with plywood between the frames and double faced with plywood—took a transverse load of 200 lb. per square foot. The weakest—wooden frame with an upper face of wood sheathing and built-up roofing and a lower face of fiberboard lath and plaster—could withstand only 23 lb. per square foot. The strongest floor—steel frame with a steel lower face and an upper face of concrete—carried a load of 379 lb. per square foot. The weakest carried less than one-tenth as much on a wooden frame with a wood subfloor and wood and paper finish.

But what you, the consumer, really want to know, is not just how strong each type is, but how its strength compares with what is needed for your house design at your site.

This ratio between allowable load and design load is called by engineers the "utility factor." It reveals at a glance whether a type of construction is suited to a house of a given design in a given place. If the utility factor is less than 1, then the house would obviously be dangerously weak. If the ratio gets up much over 2, then the house will be too strong for its job—you're wasting money on unneeded materials and workmanship.

Since the wind and snow loads vary so greatly by region, these utility factors will also vary widely. To give some idea of how they work out in three different parts of the country, the Bureau of Standards engineers took two stock house designs and worked out the design load for Portland, Me., Miami, and Los Angeles. Then they figured the utility factor of each kind of construction in each house at each place.

Pick a House to Suit Your Site

The results showed that you should pick your construction methods according to where you live, as carefully as you pick a suit according to the weather. A sheet-steel framed roof with galvanized sheet-steel facing, for example, is more than nine times as strong as needed for Los Angeles. In Portland, its utility factor is 1.2, just about right. Set it down in Miami and the utility factor drops to .9—which means that it would be only nine-tenths strong enough to withstand Miami's peak winds.

In general, however, most of the utility factors ran 'way over rather than dangerously under the safety point. Trial and error have weeded out types of construction that would be dangerously unsafe under the loads found in most parts of the country. The overbuilding from not knowing exactly the margin of safety has, however, cost millions of dollars in wasted time and labor.

Now, with exact figures on hand for the first time, the Bureau of Standards hopes that building codes will be matched to the needs of each locality—and adapted to the latest building methods. When every house is as strong as it needs to be—but no stronger—there will be more houses for all of us. END

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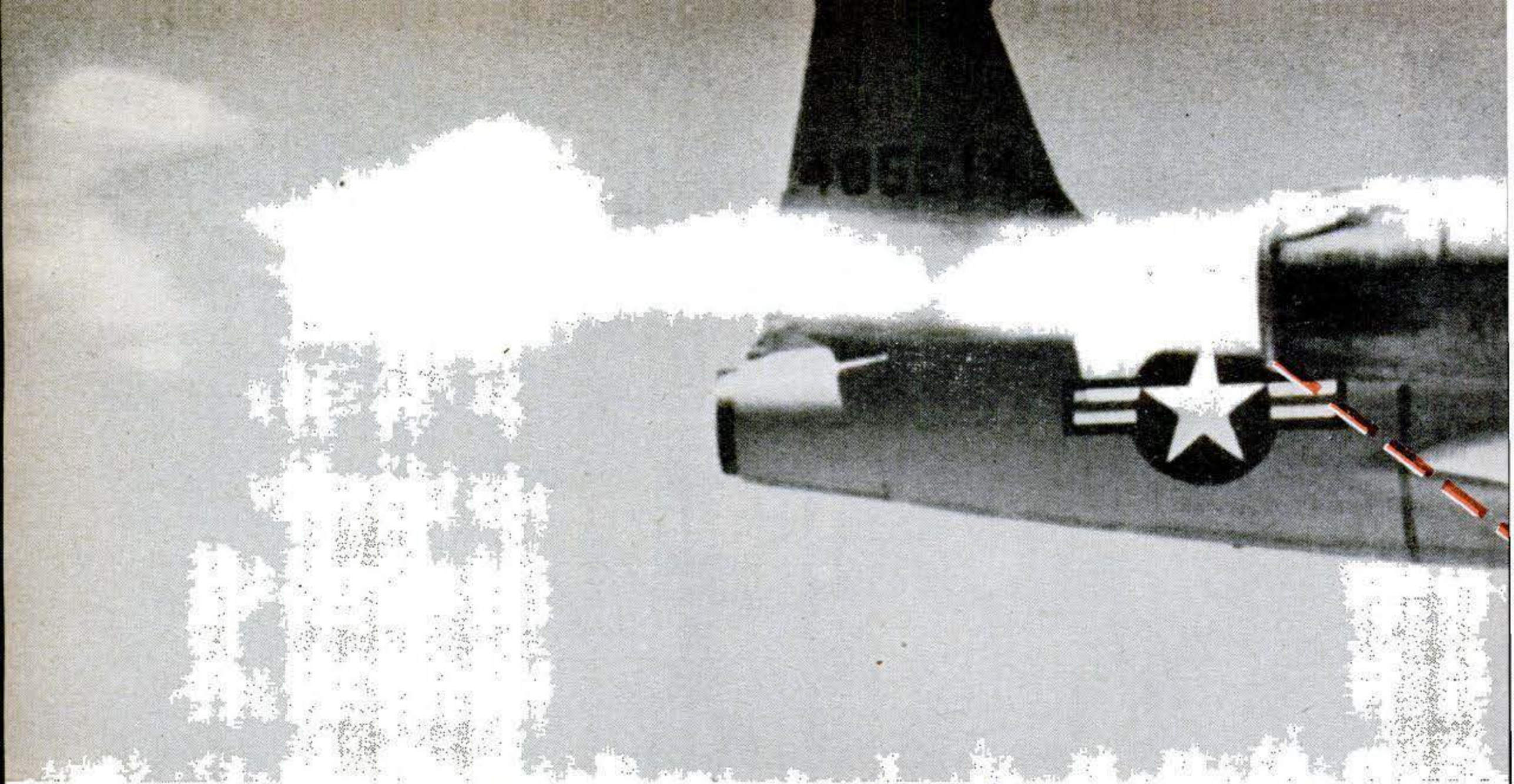
These Men Are Not Jugglers

Magnetism balances nails and penny on one man's nose, and nails on end in another's hand.

NO ONE is more surprised than the performers at the magical stunts they are exhibiting above. They are reporters attending the first public demonstration of the world's mightiest magnet. Columbia University will use it, for atomic research, in a cyclotron of record-breaking power under construction at Irvington-on-Hudson, N. Y.

When 2,000 amperes of current surge through the great magnet's coils, tricks that would leave professional jugglers goggle-eyed are easy for bystanders a few feet away. Nails and steel pennies, standing on end and clinging together in strings, align themselves with the magnetic lines of force. A plate of nonmagnetic aluminum virtually "floats" in midair between the magnet poles, and can be withdrawn only by all a man's strength, since any attempt to move it induces "eddy currents" that act as a magnetic brake. Despite its intensity, the magnetic field has no effect on human beings. END

Aluminum plate, "floating" between magnet poles, resists pull of Dr. E. T. Booth of Columbia.



This F-80 Shooting Star is the first man-carrying airplane to fly by ramjet power alone.

Riding the Ramjet

A new power plant that has sped robot missiles along at 1,800 miles an hour

By Herbert Johansen

FOR the first time, a human pilot has been carried through the air by a power plant without moving parts. The ramjet, a self-feeding blowtorch, is a simple tube gulping air that is compressed by the ram effect of its own forward movement. The air is sprayed with fuel, burned in a combustion chamber, and spewed out the tail at high velocity. The greater its speed, the more air the plane gulps; and the greater the thrust, the faster it goes.

Two of these ramjet "stovepipe" engines, installed on the wingtips, have been hitching rides on an F-80 Shooting Star jet fighter as a flying test stand. Although announced as a program of basic research, it is logical to conclude that the goal of the joint Air Force-Lockheed experimental program is the development of power packages that will make possible piloted-airplane flights far into the supersonic speed range.

Theoretically, there is no limitation to the speed of a ramjet. As greater speed increases the intake of air, the mass of gas exploded in the combustion chamber is greater, and the faster it goes, ad infinitum. Using atomic heat, this might make possible the speed of seven miles a second, or 25,000 m.p.h., necessary to escape from the earth for a flight to the moon. Since there is no air in outer space and the ramjet could no longer function, it could then be turned off. Then there would be a period of free coasting until reverse booster rockets were turned on to decelerate for a lunar landing.

But to get back to earth, and to the ramjet of today—it is the simplest of engines in both construction and operation. It does, however, require high initial air speeds to operate independently. The Navy, using booster rockets for take-offs, has sent pilotless, guided-missile-type ramjets zooming

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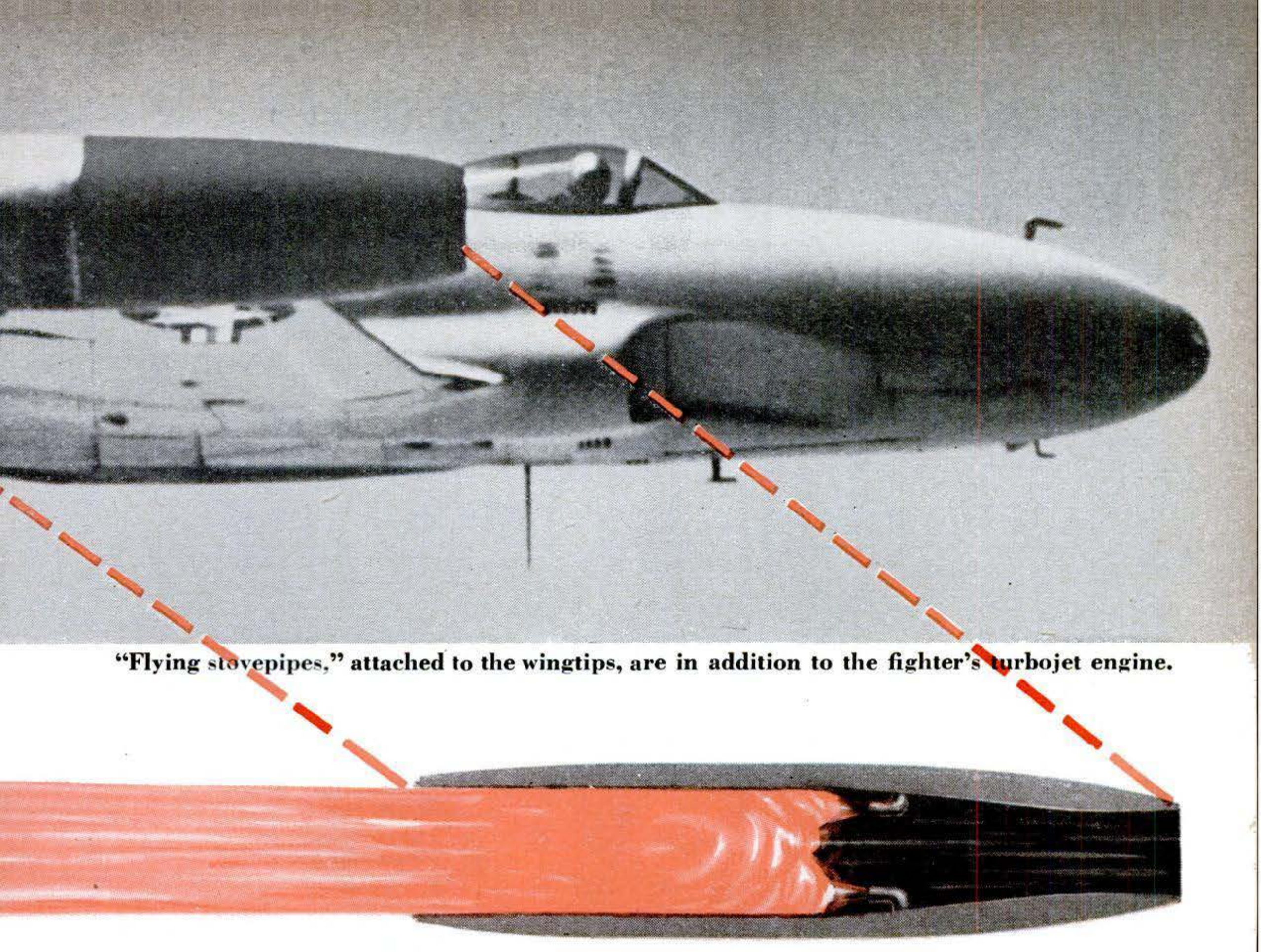


"Flying stovepipes," attached to the wingtips, are in addition to the fighter's turbojet engine.

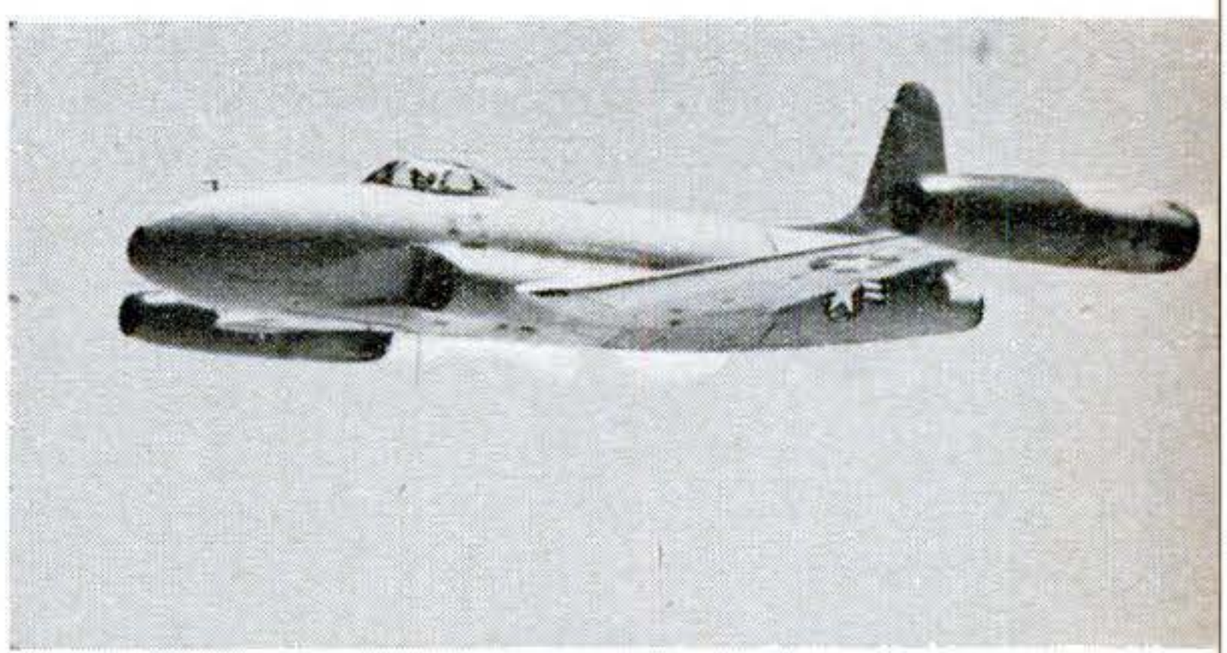
now pushes a human pilot—but how fast it goes is a secret.

skyward at better than 1,800 miles an hour.

In the experimental F-80, the initial speed was obtained by the fighter's General-Electric-designed Allison turbojet engine, capable of 600 miles an hour. At times, however, the turbojet was turned off and the plane flown by ramjet power alone, making it the first man-carrying aircraft to achieve this type of flight.

Two types of ramjet engines, made by the Marquardt Aviation Co., of Venice, Calif., were used in the F-80 flights. One was seven feet long and 20 inches in diameter; the other, 10 feet long and 30 inches in diameter. The tubes were made of stainless steel, aluminum, and magnesium. The ignition system, which requires very hot instant flashes, is a highly guarded secret at present.

The Air Force insists that its tests, which have extended over a period of almost a year, were made to improve and develop ramjets, and not to increase the efficiency or speed of the F-80. But the experiments spontaneously excite the imagination and give added weight to the prediction of some scientists: that the youth of today will live to see a flight into space beyond the earth, whether it be by rocket propulsion or by ramjet. END



The F-80, seen in ramjet flight, may be a preview of how we'll fly at high supersonic speeds.

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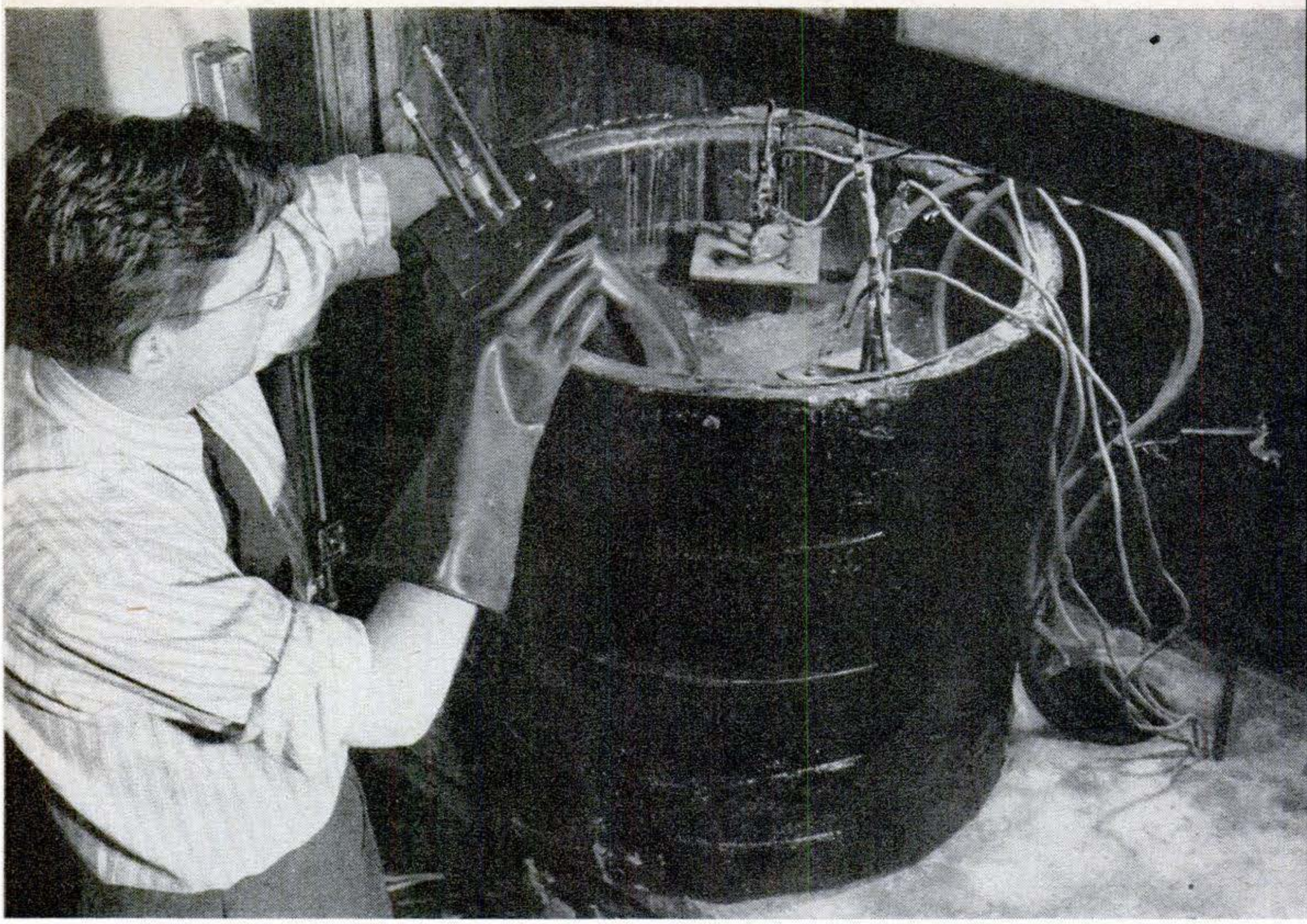

Reaction chamber for laboratory production of fluorocarbons at Pennsylvania State College looks like a sawed-off barrel. It holds ice and brine for controlling temperature of single electrochemical reaction cells. With this apparatus, experimenters in the school's Fluorine Laboratories at State College, Pa., have produced more than 100 sturdy fluorocarbon compounds.

New Materials

Fluorocarbons from a little black box make everlasting oil, fireproof paints, and indestructible building materials.

By George H. Waltz, Jr.

Photos: du Pont, Penn State, Hubert Luckett for PS

REVOLUTIONARY, indestructible materials are flowing out of a magic black box in a small laboratory in central Pennsylvania.

The box is an electrochemical reaction chamber, no bigger than a large barrel. The laboratory is one of many on the Pennsylvania State College campus. The materials it produces are known as fluorocarbons.

From these materials soon will come improved fire extinguishers; fireproof paints, fabrics, plastics, and building materials; wire insulation that will stand up under extremely high temperatures; heat-resistant fluids for driving turbines; and lubricating oil for your car that will never wear out!

Fluorocarbons are the sturdy first cousins of hydrocarbons. Our food and fuels are hydrocarbons. They consist of atoms of hydrogen linked to atoms of carbon—the basic element of all living matter—to form chain and ringlike molecules. In the fluorocarbons, fluorine, the most active chemical element yet discovered, replaces the hydrogen in the molecule and is linked to the carbon atoms.

Physically and structurally, the fluorocarbons resemble the hydrocarbons. Chemically, however, they are vastly different. The hydrocarbons invite chemical action; the

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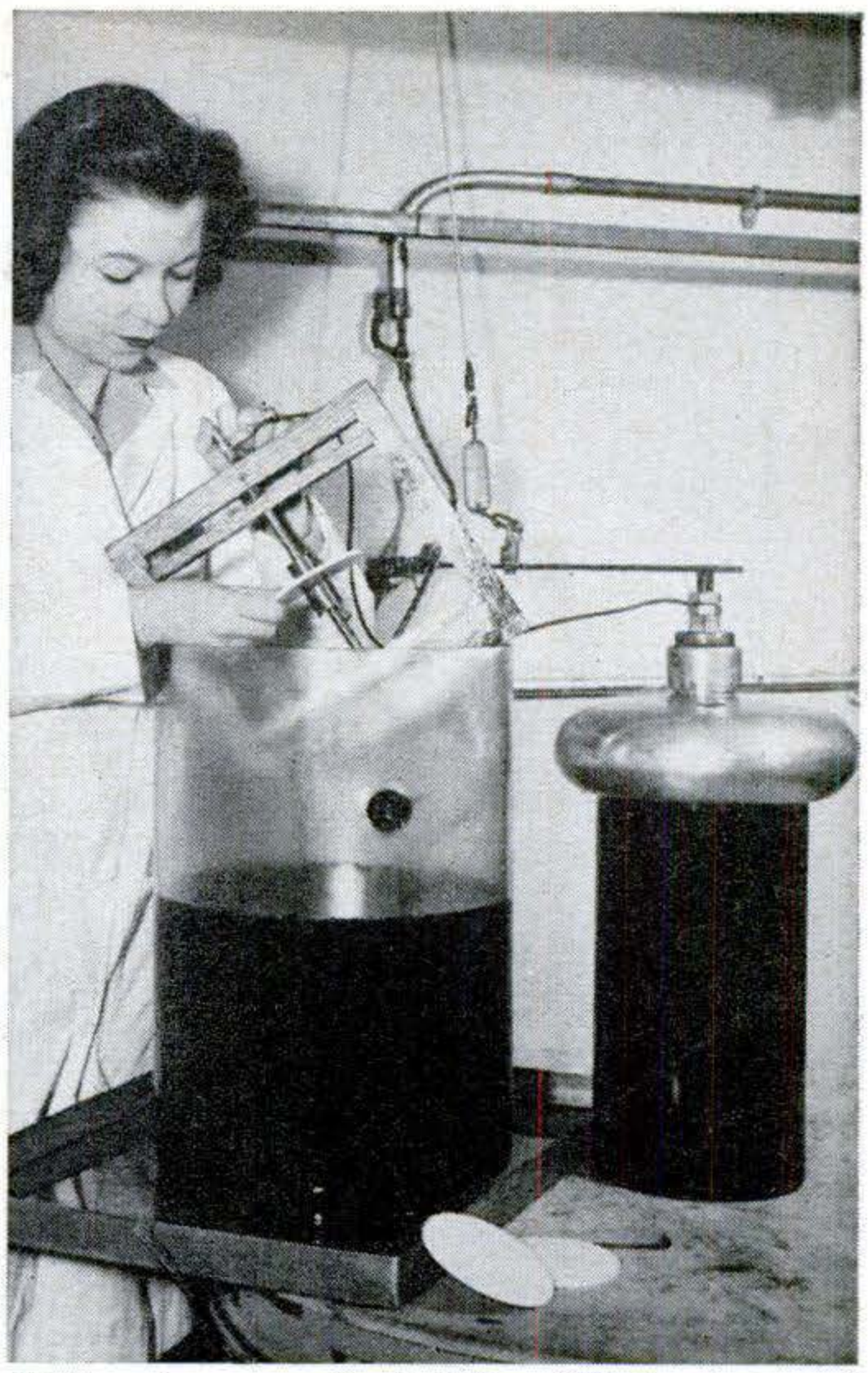
Indestructible fluorocarbon plastic is tested by boiling in sulphuric acid. Rod at right, a du-Pont product called Teflon ®, is unaffected; rod of ordinary plastic at left is badly charred.



Dielectric strength of disks of Teflon is tested under high voltages. Its high insulating qualities make the new material valuable as a non-conductor in radar and television equipment.

Won't Wear Out

fluorocarbons defy it. Whereas ease of combustion or burning makes the hydrocarbons valuable to us as foods and fuels, the chemical inertness of the fluorocarbons makes them ideal ingredients for tough, long-wearing products in thousands of different industrial fields ranging from power generators to electrical appliances and from automobiles to textiles.

Why, you are probably wondering, if the fluorocarbons are similar to the hydrocarbons in structure, are they so steadfastly stable and the hydrocarbons so unstable? Fluorine's characteristics explain the difference. It is the most active and tenacious element known (PS, Sept. '46, p. 134). Once it combines with carbon to form a fluorocarbon, it hangs on, defying any efforts to pull the molecule apart. The bond between the fluorine and carbon is so tight that most fluorocarbons will react chemically only under extremely high temperatures that would disintegrate any type of container.

The indestructibility of the fluorocarbons made them particularly valuable during the war. Early in the atomic project, for example, containers—crucibles and bottles—were needed to hold and store the extremely active uranium hexafluoride used in the process. Containers made of fluorocarbons provided the answer. Many of the workers around the nation's atomic piles today are protected by coveralls impregnated with indestructible fluorocarbon compounds.

The wartime fluorocarbons, however, were extremely costly. They were produced by a dangerous, expensive, and involved multistep chemical process that made their use in

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any but the most important and specialized applications highly impractical. Now this difficulty is being overcome. A few weeks ago, Dr. J. H. Simons, long a recognized authority on fluorine chemistry and head of the Pennsylvania State College Fluorine Laboratories, revealed the details of his magic black box. With it, he can produce fluorocarbons—literally thousands of different kinds—at a cost that soon should make them available for general use.

U. S. Now Gets All

A pilot plant now operating at the St. Paul, Minn., headquarters of the Minnesota Mining and Manufacturing Co. (maker of Scotch Tape ®), is producing 40 pounds of the indestructible materials a day. At the moment, the entire output is being delivered to the Government for use in military experimental work. But larger plants can be built.

Until recently, chemists produced fluorocarbons in small quantities either by using fluorine gas, which is dangerous and difficult to handle, or by an elaborate, tedious, and costly series of chemical reactions. Dr. Simons now produces them electrochemically by a safe, single reaction employing hydrogen fluoride rather than fluorine.

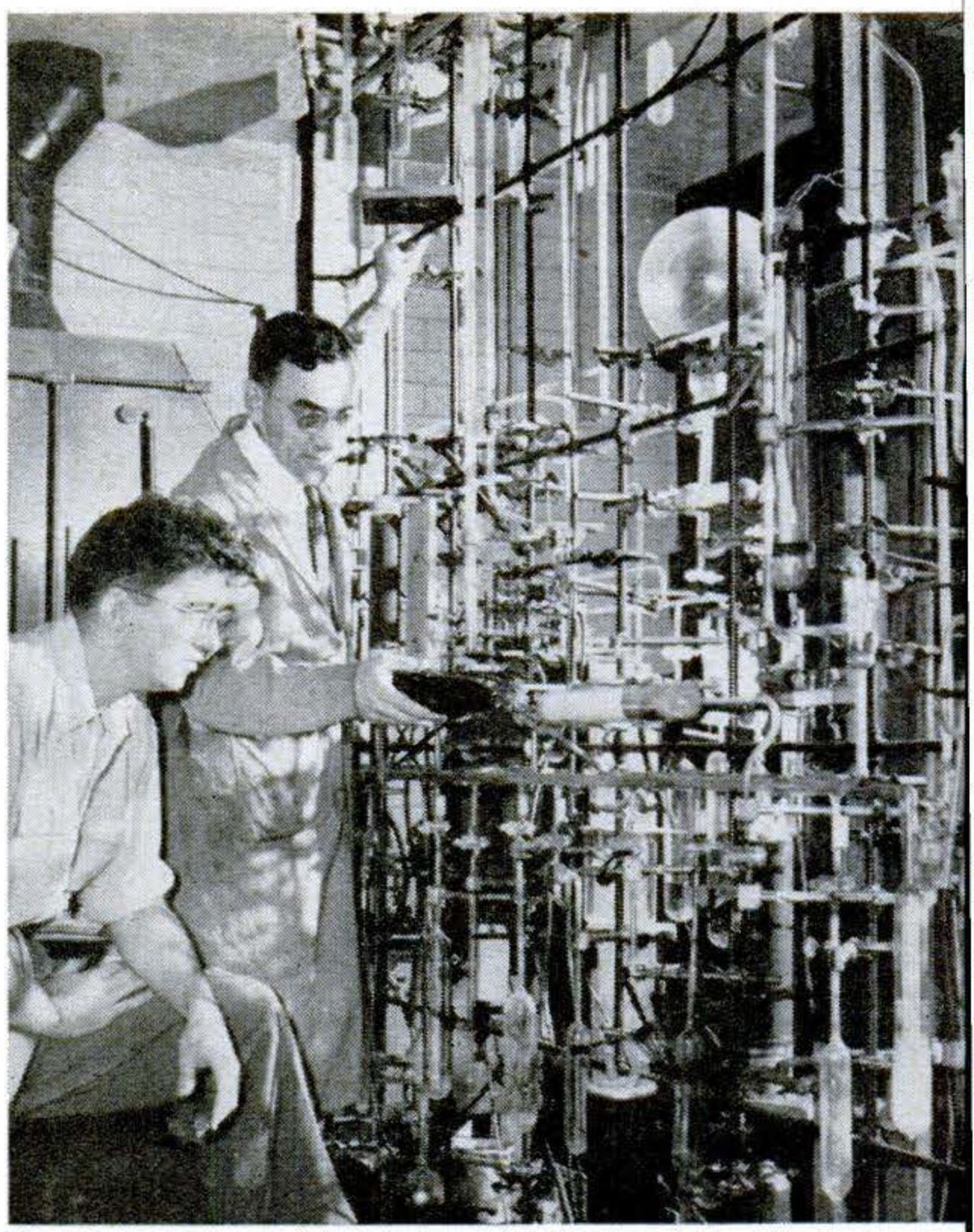
His black box is simply an iron reaction cell containing positive and negative electrodes. In the pilot-plant model of the cell, these electrodes are thin sheets of nickel suspended from the top cover of the cell, resembling the stacked-up plates of a storage battery. Each nickel sheet is electrically insulated from its neighbors and electrically connected to each alternate plate to form two separate electrical packs that serve as anodes (positive) and cathodes (negative).

How Process Works

When the reaction cell is in continuous operation, hydrogen fluoride and the organic raw materials are pumped into the chamber. During the electrolysis, the fluorine from the hydrogen fluoride replaces the hydrogen in the hydrocarbons to produce hydrogen gas and fluorocarbons. It is as simple as that.

The hydrogen gas and any gaseous fluorocarbons that may be produced are tapped off at the top of the cell. The liquid fluorocarbons are drawn off at the bottom.

To maintain the proper temperature for the reaction, the pilot-plant cell is refrigerated. In the laboratory, where small cylindrical reaction cells are used to produce small quantities of the fluorocarbons, they are immersed in a solution of ice and brine.



Dr. J. H. Simons (right), head of Penn State's Fluorine Laboratories, perfected the new, simple method for producing fluorocarbons. He is shown examining equipment for testing them.

Similar electrochemical processes are widely used in industry to produce such things as chlorine, aluminum, and lye. In many of these cells, however, diaphragms must be used to separate the anodes from the cathodes, because of the possibility of interaction between the products. In Dr. Simons' fluorocarbon cell, the very quality of stability that makes the fluorocarbons indestructible also makes any interaction impossible. Since diaphragms are unnecessary, the cells can be small and compact.

Dr. Simons has been experimenting for some 25 years with fluorine—a gas that was discovered 135 years ago but defied isolation for 73 years. Because it is a dangerous gas—*no plaything for amateurs*—research was difficult. About 10 years ago, Dr. Simons made an interesting discovery. Always before, when carbon was burned in an atmosphere of fluorine, the experiment ended in an explosion. This particular time it did not. By chemical detective work, Dr. Simons found the reason: a catalyst had been left, unin-

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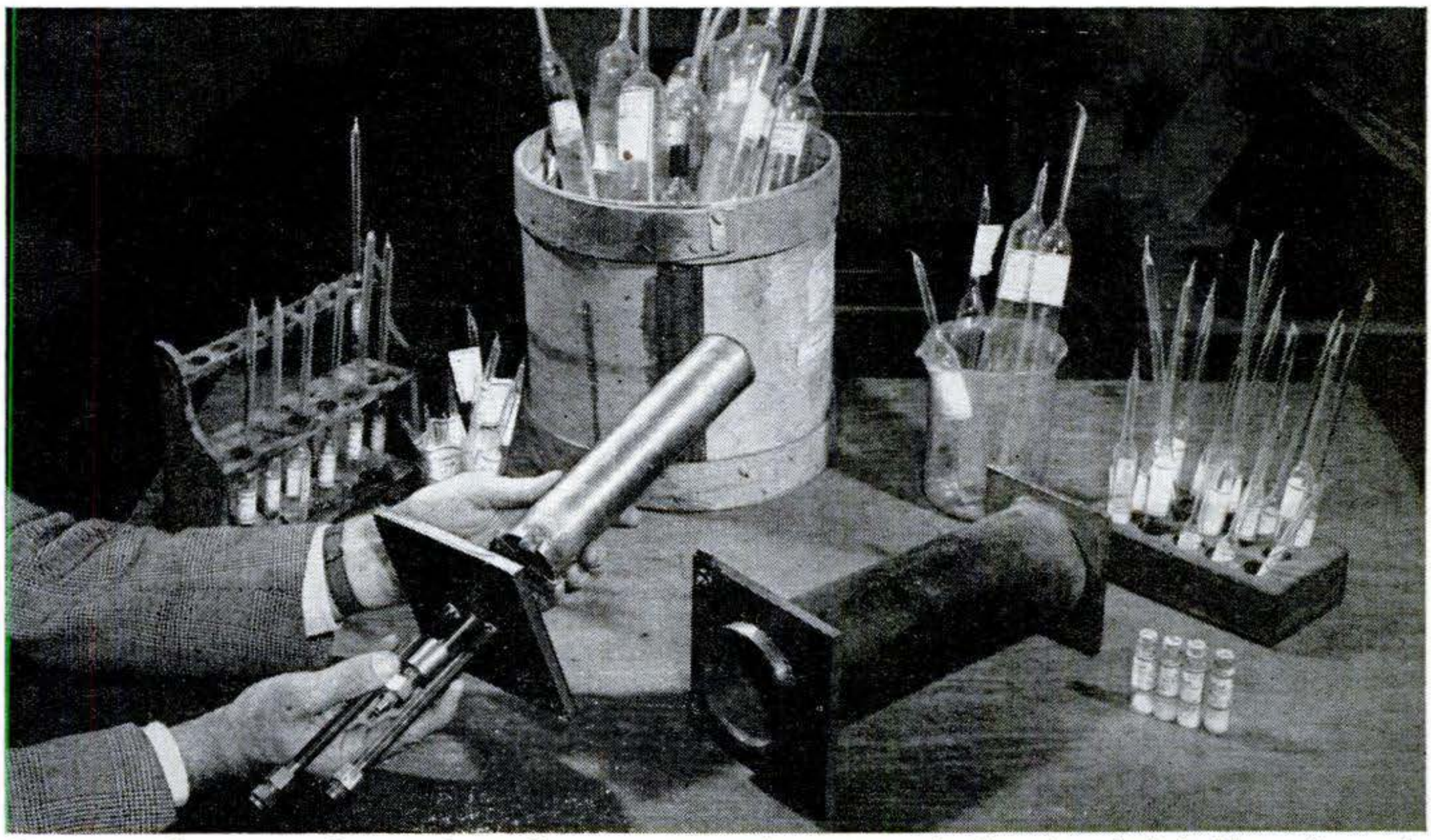
This maze of glass bulbs and tubing is a single piece of laboratory testing apparatus. Liquid fluorocarbons, produced in the reaction chamber pictured on page 132, are fed into one end of this complicated plumbing system and tested progressively for each of their physical properties as they flow through. It takes five men to manipulate the various valves during such tests.



Close-up shows simplicity of single reaction cell used to produce fluorocarbons in laboratory. Outer casing of cast iron (right foreground) serves as cathode in this experimental type. The inner cylinder of nickel, held in the technician's left hand, serves as the anode. Behind the disassembled cell are tubes and vials containing some of its varied flurocarbon products.

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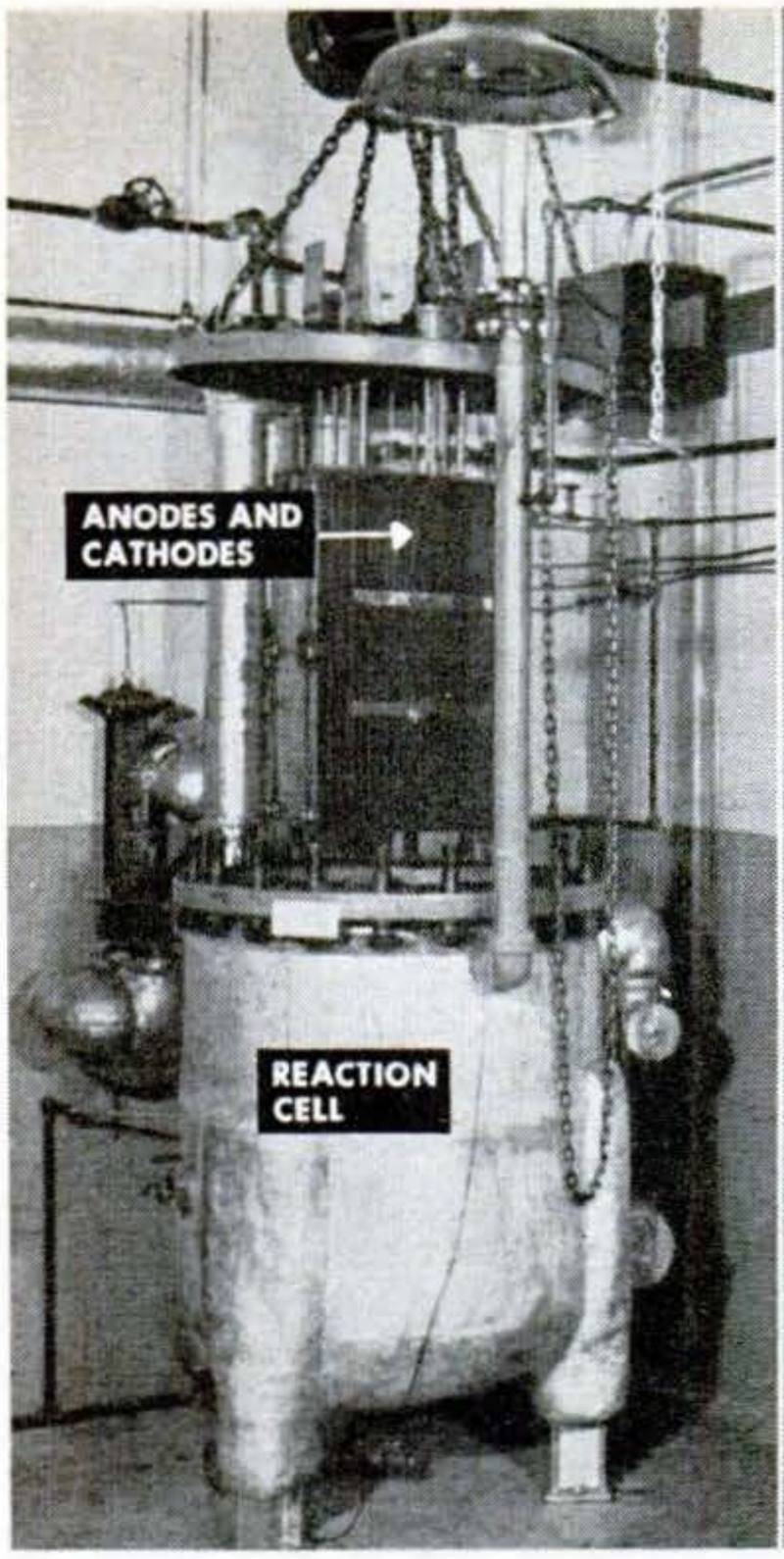

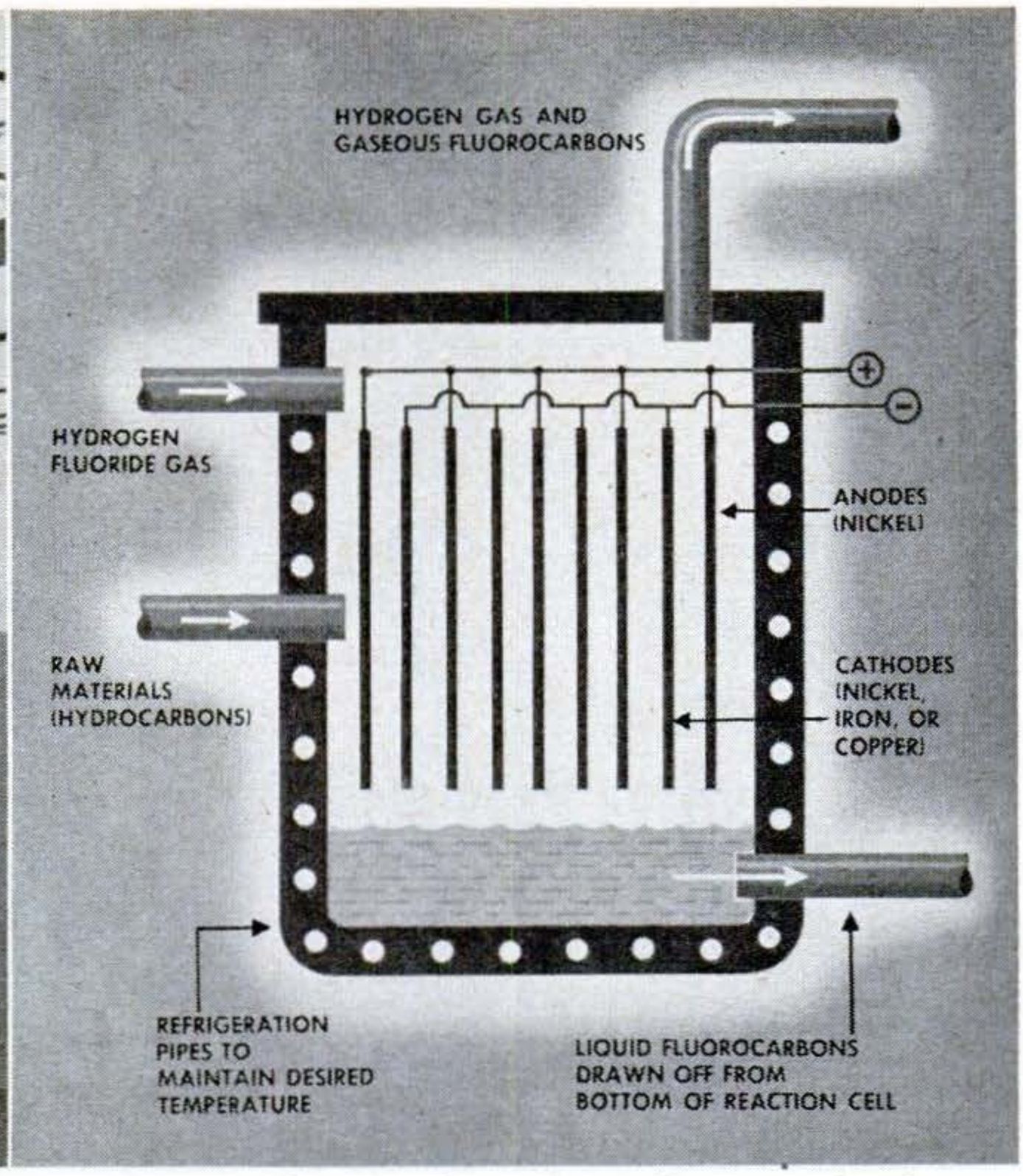

This pilot plant for producing fluorocarbons commercially is now operating at the St. Paul plant of the Minnesota Mining and Manufacturing Co. Diagram at right above shows its insides. This electrochemical reaction chamber can produce 40 lb. of the new indestructible materials a day. Its anodes and cathodes are interleaved like the plates of a giant storage battery.

tentionally, in an uncleaned laboratory tube.

When World War II broke out and the atomic experts were looking for some extremely inert chemical for containers, Dr. Simons was able to supply his old classmate, Dr. Harold Urey, with a 2-c.c. sample of the liquid fluorocarbon he had obtained from his earlier experiments. Chemical and physical tests showed it had the desired properties. At war's end, when he could return to his experimenting, Dr. Simons set out to improve the laborious, expensive wartime process for producing the fabulous fluorocarbons.

Impossible? He Did It

Many chemists told him the job could not be done electrochemically. But Dr. Simons is a man who enjoys undertaking what others say can't be done. And again he succeeded. The result is his magic black box.

So far, the experimenters at Penn State have produced more than 100 different fluorocarbon compounds and their derivatives. By controlling the pressure, temperature, voltage, and varying the raw materials, any desired fluorocarbon can be made to order. Eventually, according to Dr. Simons, it will be possible to produce an array of fluorocarbons comparable to the hydrocarbons. This will make available a million brand-new compounds that will not burn, corrode metals, or disintegrate.

The field of the fluorocarbons (or inorganic "organic" chemistry, as it aptly has been called) is boundless. The unique properties of these synthetic compounds open up endless possibilities in commercial production. Plastics, paints, wall and ceiling panels, rubber, and fabrics made from fluorocarbons will not only resist burning but will block any fire already started.

Right now it would be possible to produce a motor oil that, because it would neither burn nor break down under high temperatures, would last forever. The crankcase of the car using it could be filled and sealed at the factory, and its initial filling of fluorocarbon oil would outlast the car.

"Asking for what the fluorocarbons will be used," says Dr. Simons, "is something like asking Michael Faraday what good were the first electric motors and dynamos." END

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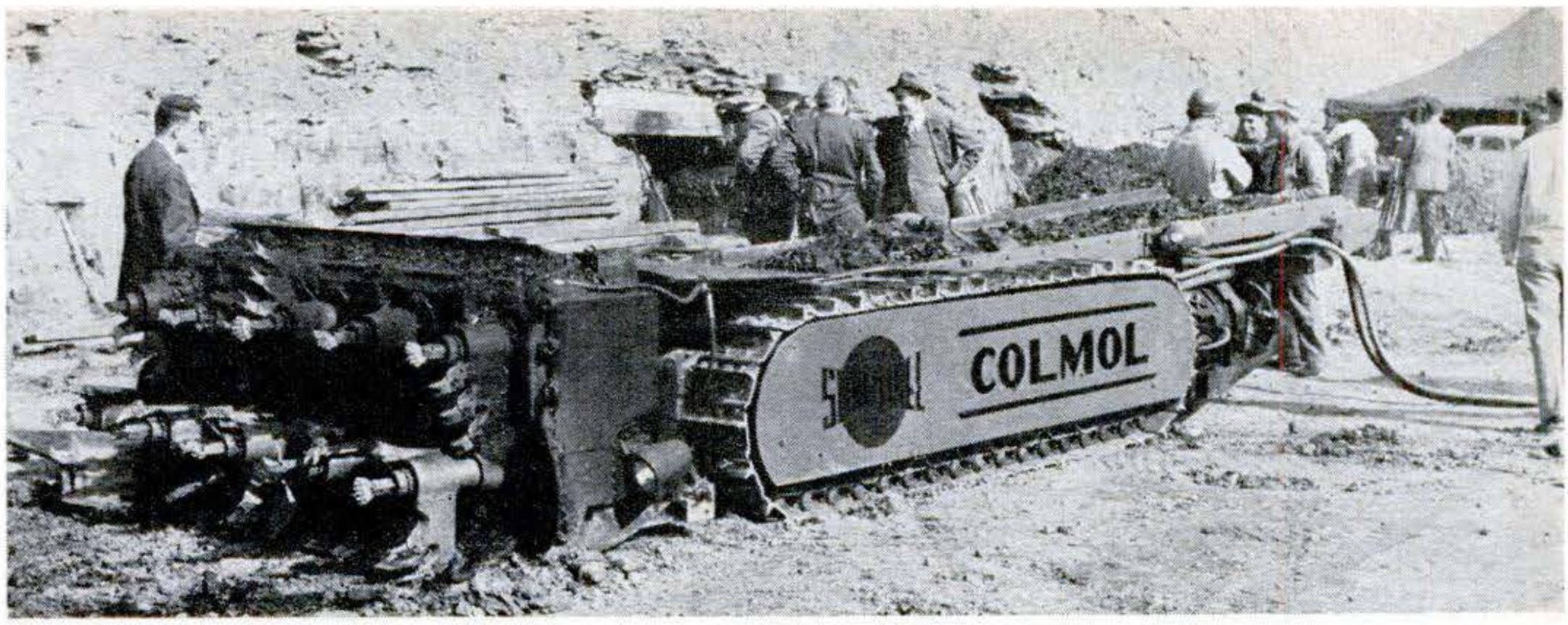


Coal Mining Made Easy

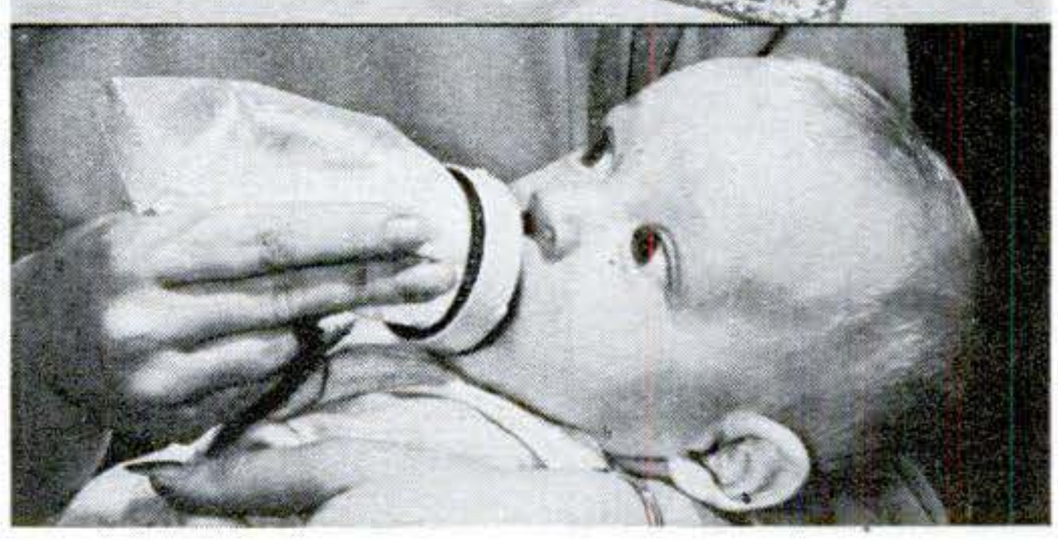
LIKE a giant mole, the machine shown above advances continuously and automatically as its rotary chipping heads cut into a 4- by 9.5-ft. coal face. As it bores in, the loosened coal is swept back onto a conveyer system. A four-man crew is expected to be able to mine 500 to 1,000 tons a shift with the machine and mobile conveyers—6 to 50 times current production. Under development by the Sunnyhill Coal Co., of Pittsburgh, the Colmol® eliminates several steps in coal-mining methods.

Throw-Away Bottles Save Time and Burps

DISPOSA-BOTTLES®, cheap enough to throw away once used, save mothers the bother of washing and boiling nursing bottles. And because they're squeezable, they save babies discomfort from swallowing air and sucking against a semi-vacuum. Presterilized, the bottles come as a long roll of flattened plastic-film tubing sealed off into 65 8-oz. or 100 4-oz. sections.

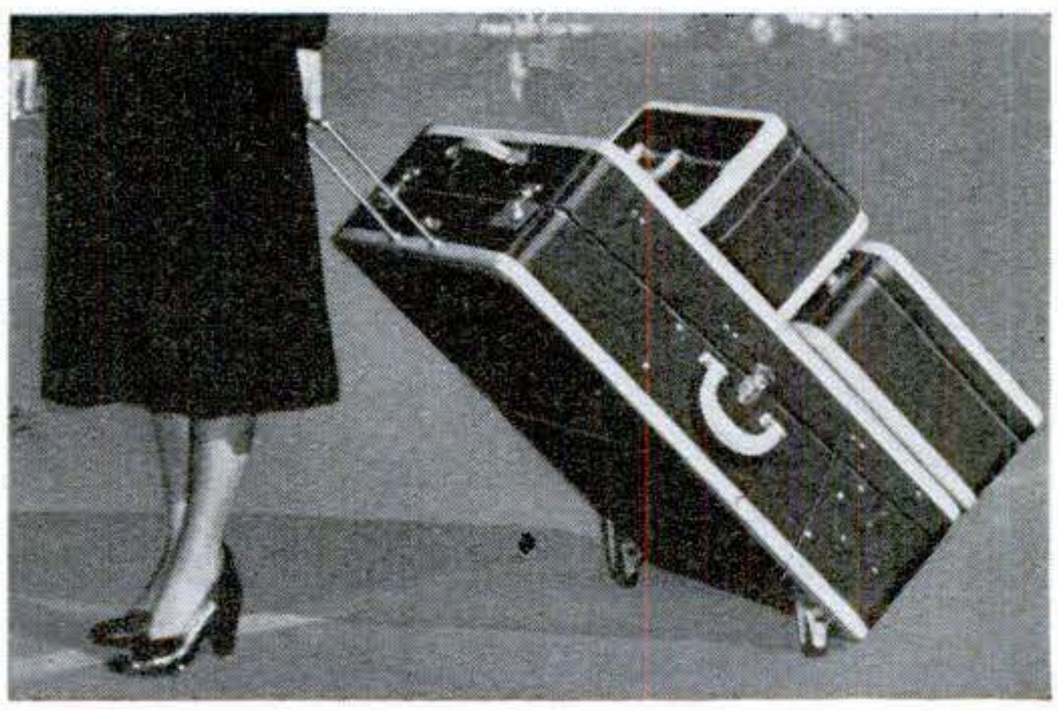
To fill one, you snip it off, slip the open end over an expansion ring, hang it on a rack (top photo at right), and pour in the milk. A second ring locks the nipple on. A leak-proof cap is added for storage.

At feeding time the bottle is warmed under a hot-water faucet, and the air is squeezed out before Junior goes to work.



Luggage Sprouts Wheels

NO PORTER around when you arrive at airport or railroad terminal? That's no problem if you have a Rollaway® suitcase as shown at right. Just pull out a handle from the top and, presto, two wheels pop out like a plane's landing gear. Got a couple of extra bags? That's easy: pull out two supporting extension arms, and pile them on. The Rollaway was developed by MacArthur Products, of Indian Orchard, Mass.



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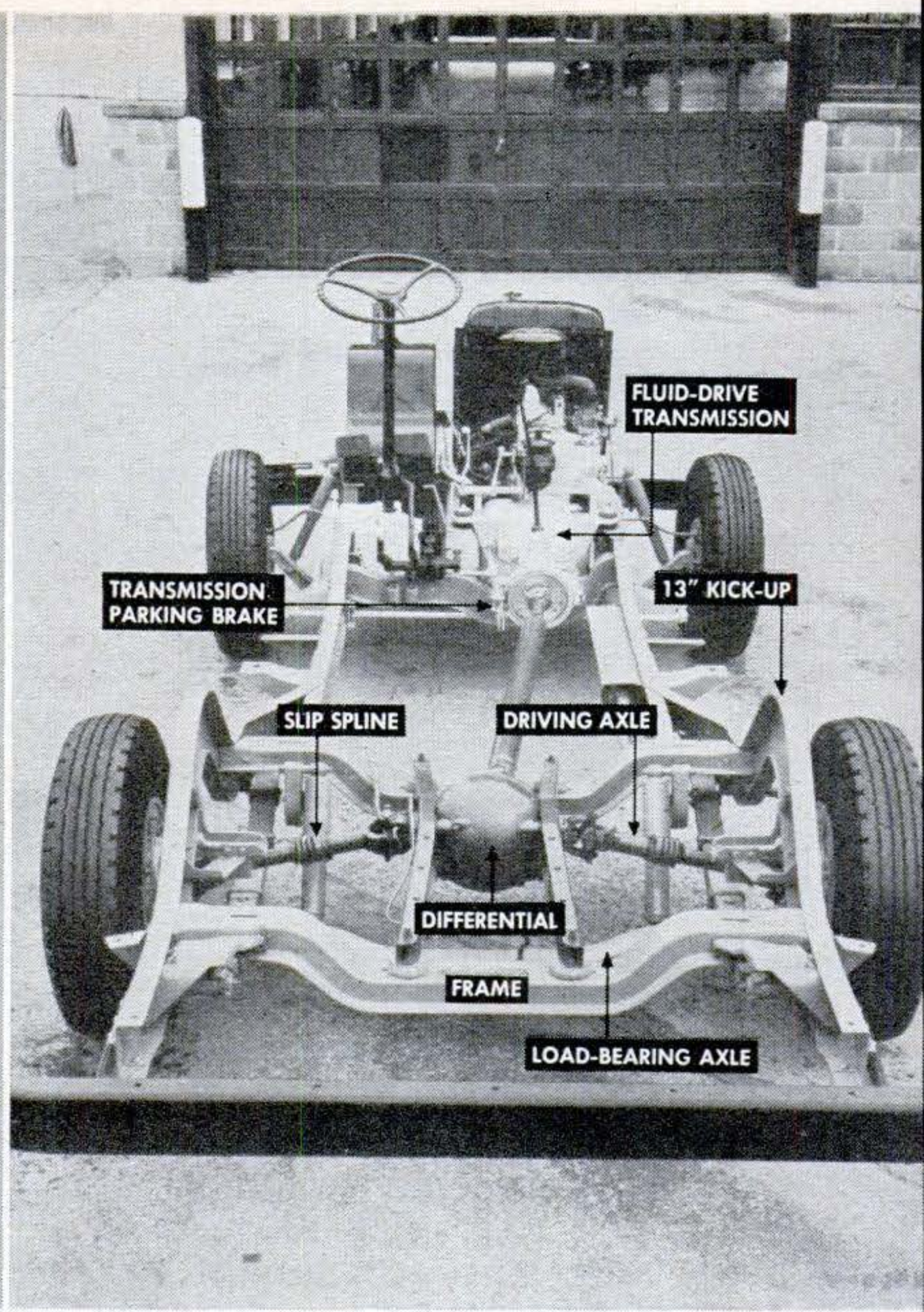
New Dodge van has larger windshield and window area for better visibility. This model has 2700-lb. load capacity.

New Truck Has Two Rear Axles



Upsweep of side frame members allows full up-and-down axle movement. Placed between these members, van floor is nearer ground. Driver can step in and out with less effort.

By R. P. Stevenson

DODGE'S new door-to-door delivery van has two rear axles. One supports the load, the other transmits power to the wheels.

The reason for the second axle is interesting. Drivers step in and out of frequent-stop delivery trucks several hundred times a day. That adds up to a lot of tired muscles. Because of the new rear-end design, it's possible to drop the truck floor nearer the pavement—and take some of the strain off the drivers.

The load-bearing axle is a down-sweeping member rigidly attached to the backing plates of the brake drums. Heavy leaf springs join it to the frame. Shock absorbers are optional.

The driving axle consists of the differential and two shafts with slip splines and universal joints. The differential assembly is mounted in rubber directly on the chassis. Thus, it rises and falls with the truck body, instead of with the wheels as in an ordinary car or truck. Since this design provides a reduction in unsprung weight, the van goes over the bumps better.

In the driving axle, the length and angle of each shaft changes with deflection of the leaf springs. Slip splines, covered by boots, allow the shafts to telescope to compensate for loads. Two universal joints on each take care of angularity. A 13-inch upsweep in the side chassis members gives space for full up-and-down axle movement.

The new truck also offers Chrysler's Fluid Drive ® as optional equipment, first use of this transmission outside the passenger-car field.

The Route Van ® is powered by a six-cylinder, 230-cu.-in. engine of 102 hp.

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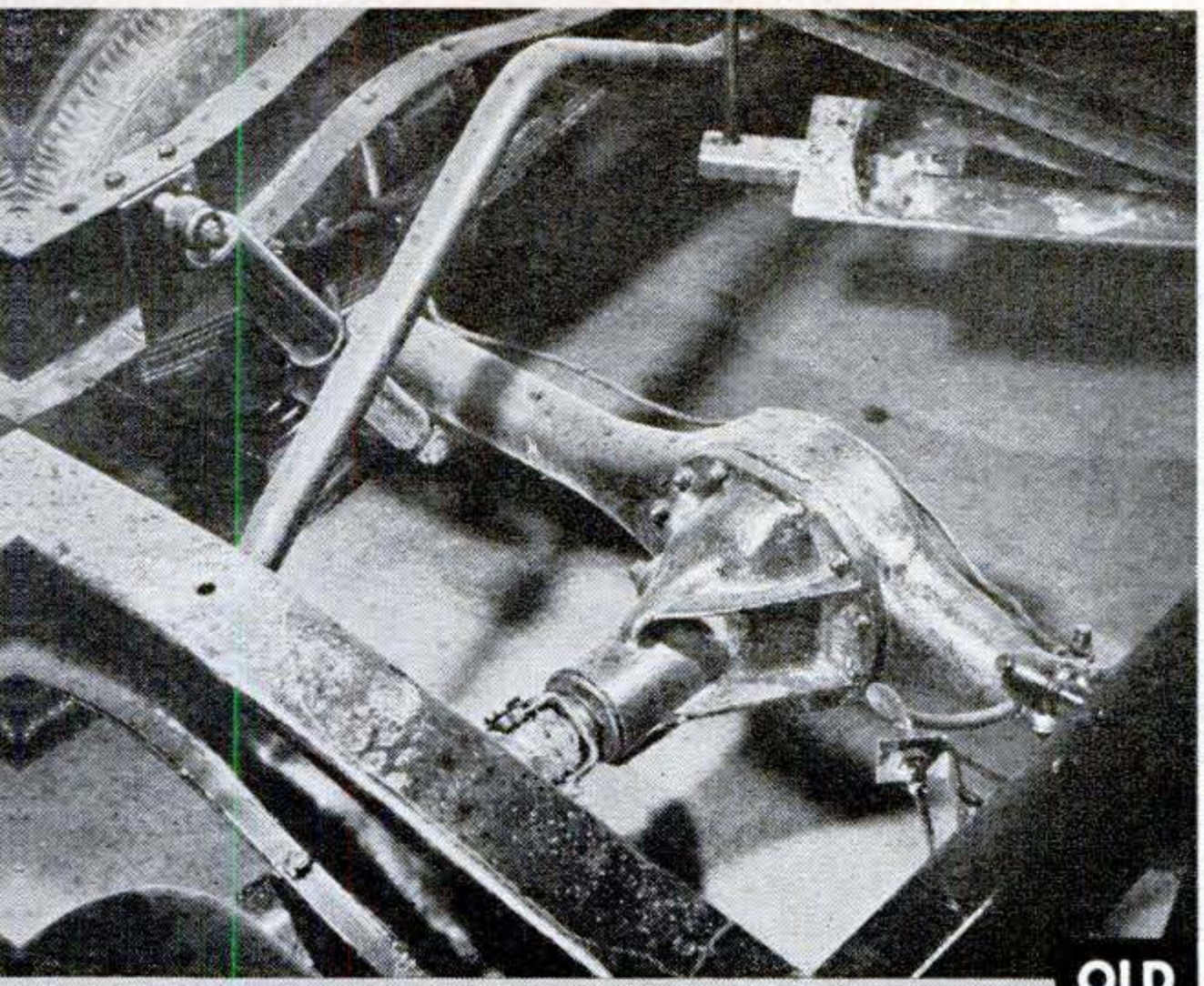
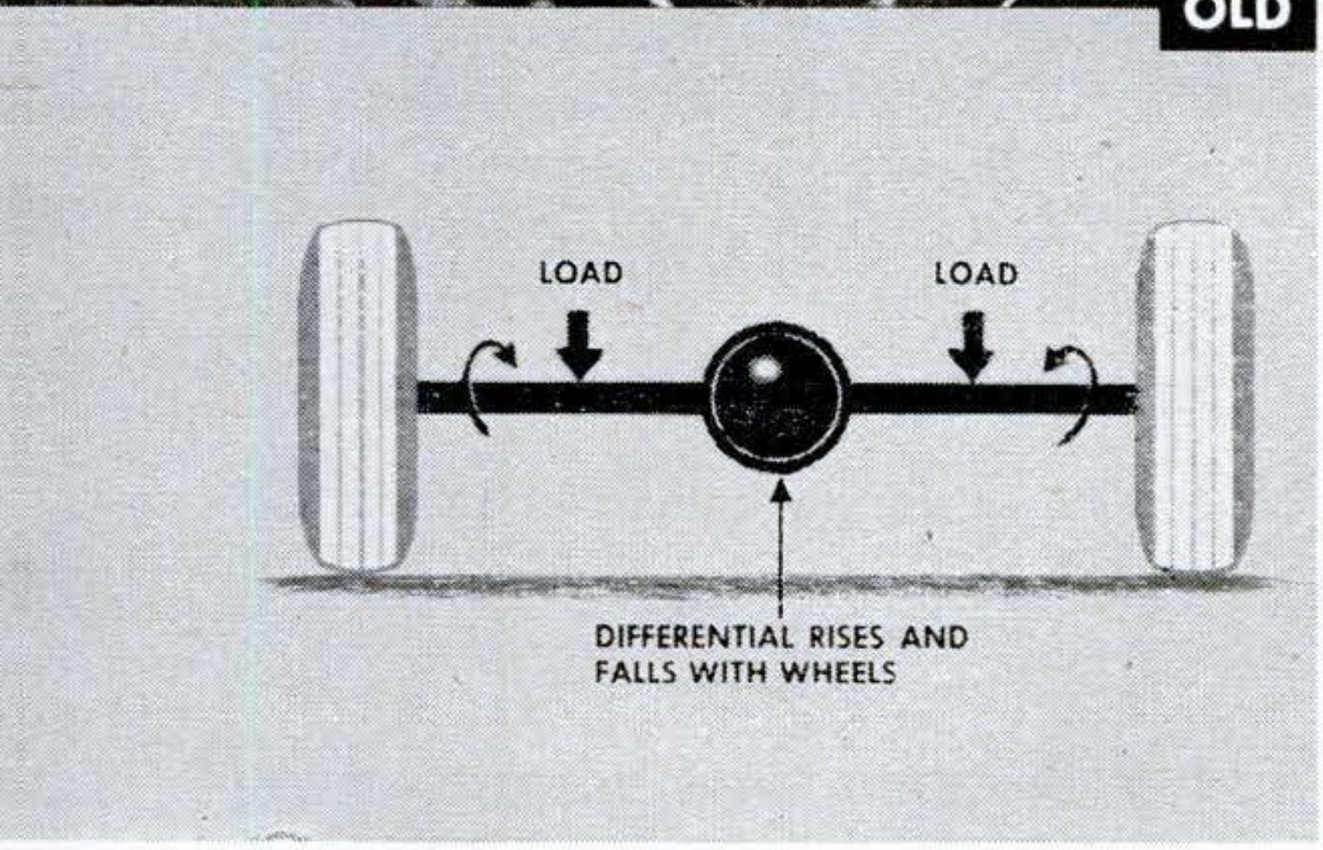
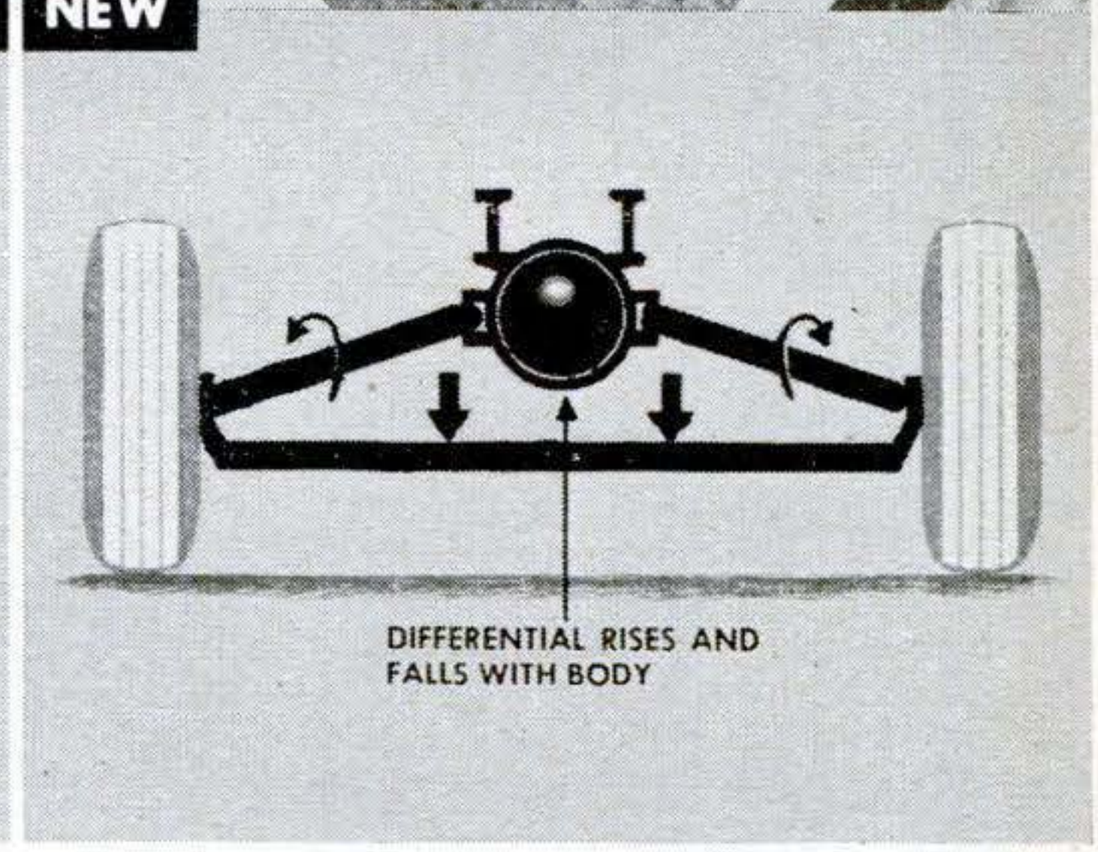


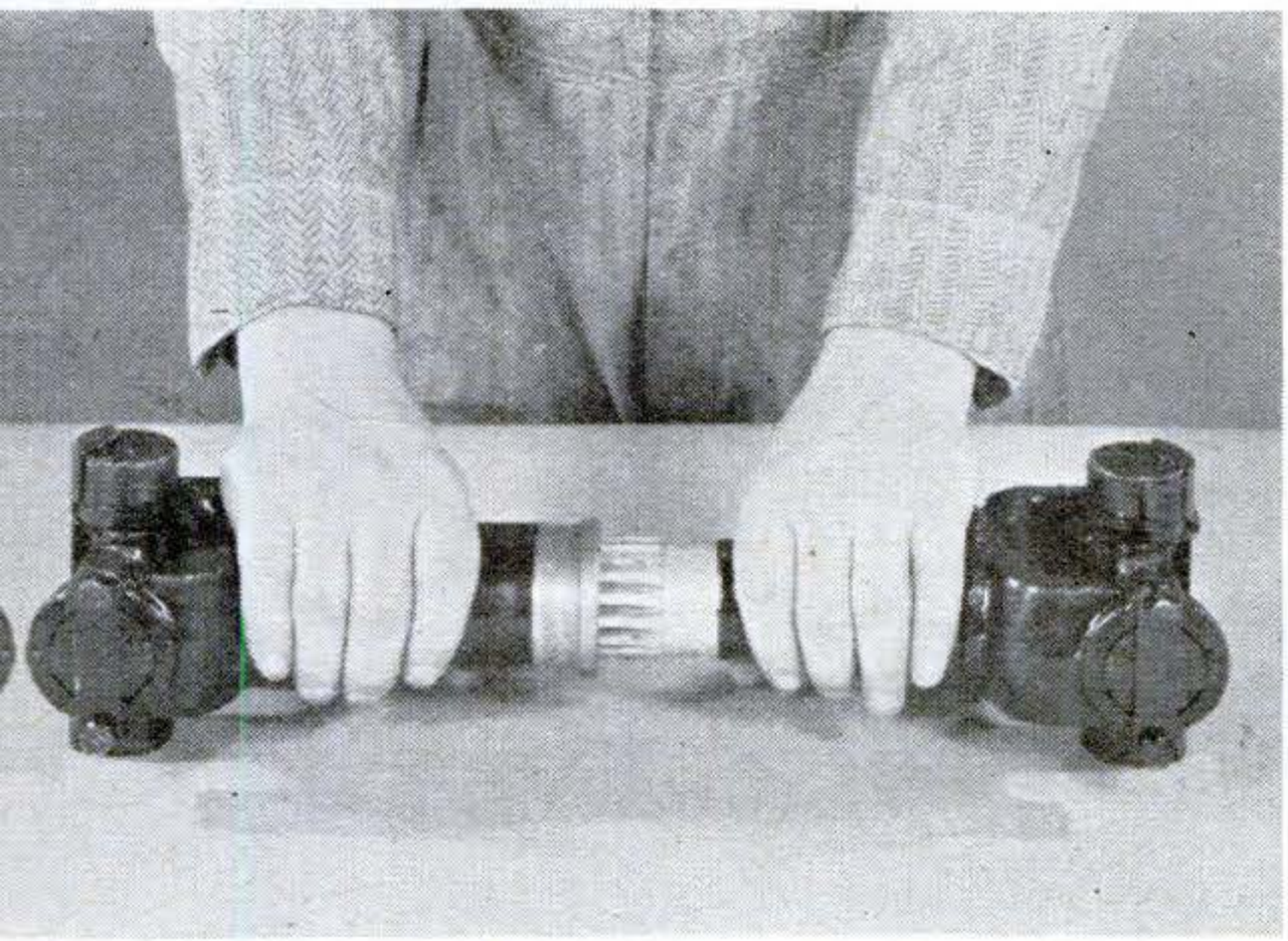
OLD NEW



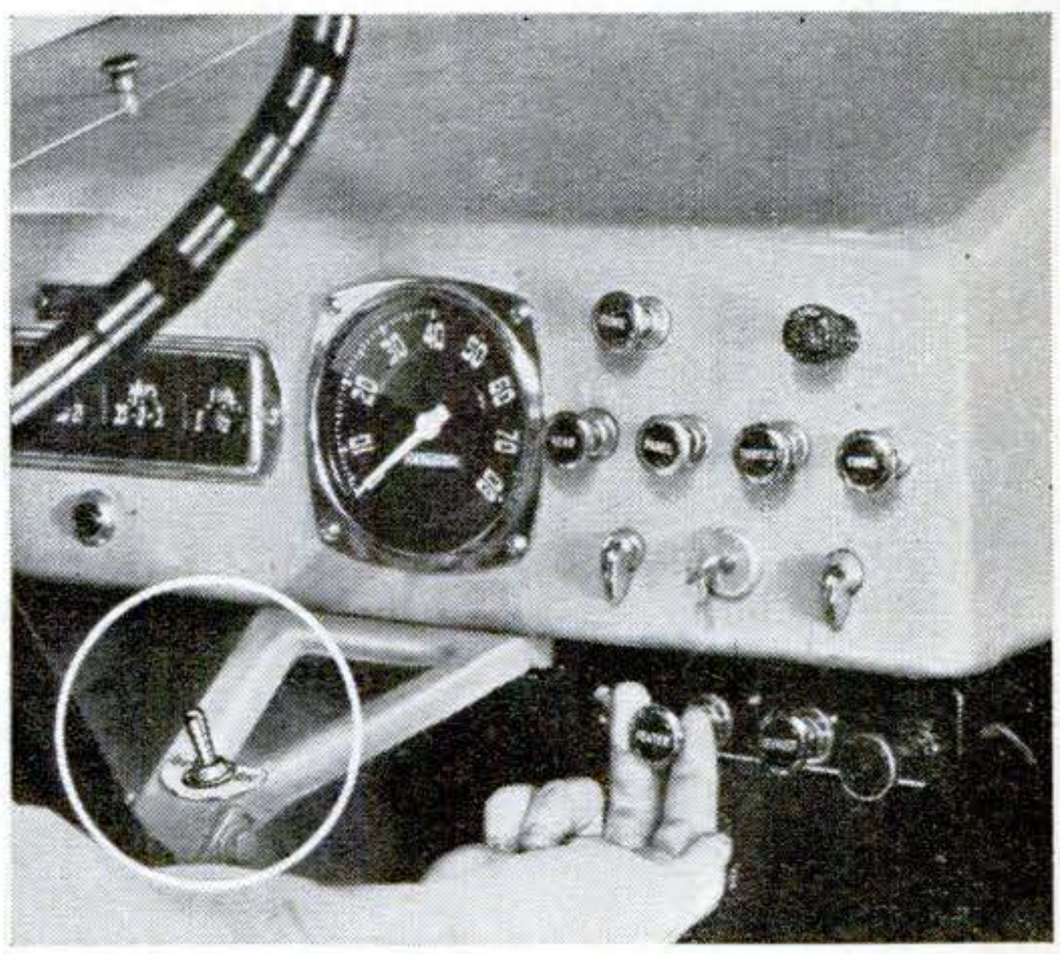


Conventional rear axle was used in last year's Dodge truck. Here, as in your own car, the power shaft is enclosed inside load-supporting housing. Now see new model, above right.

Two rear axles are found in the new Route Van. Both are seen in photo above. Near ground is one that supports the load. Between differential and wheel is seen the splined drive shaft.



A slip spline in the axle shaft allows it to change length as the truck body rises and falls. This shows it with protective boot removed. Two universal joints permit angular movement.



A switch on the steering-column bracket sets or releases the service brakes. The switch controls a hydraulic brake holder. The other controls are conveniently located on the dashboard.

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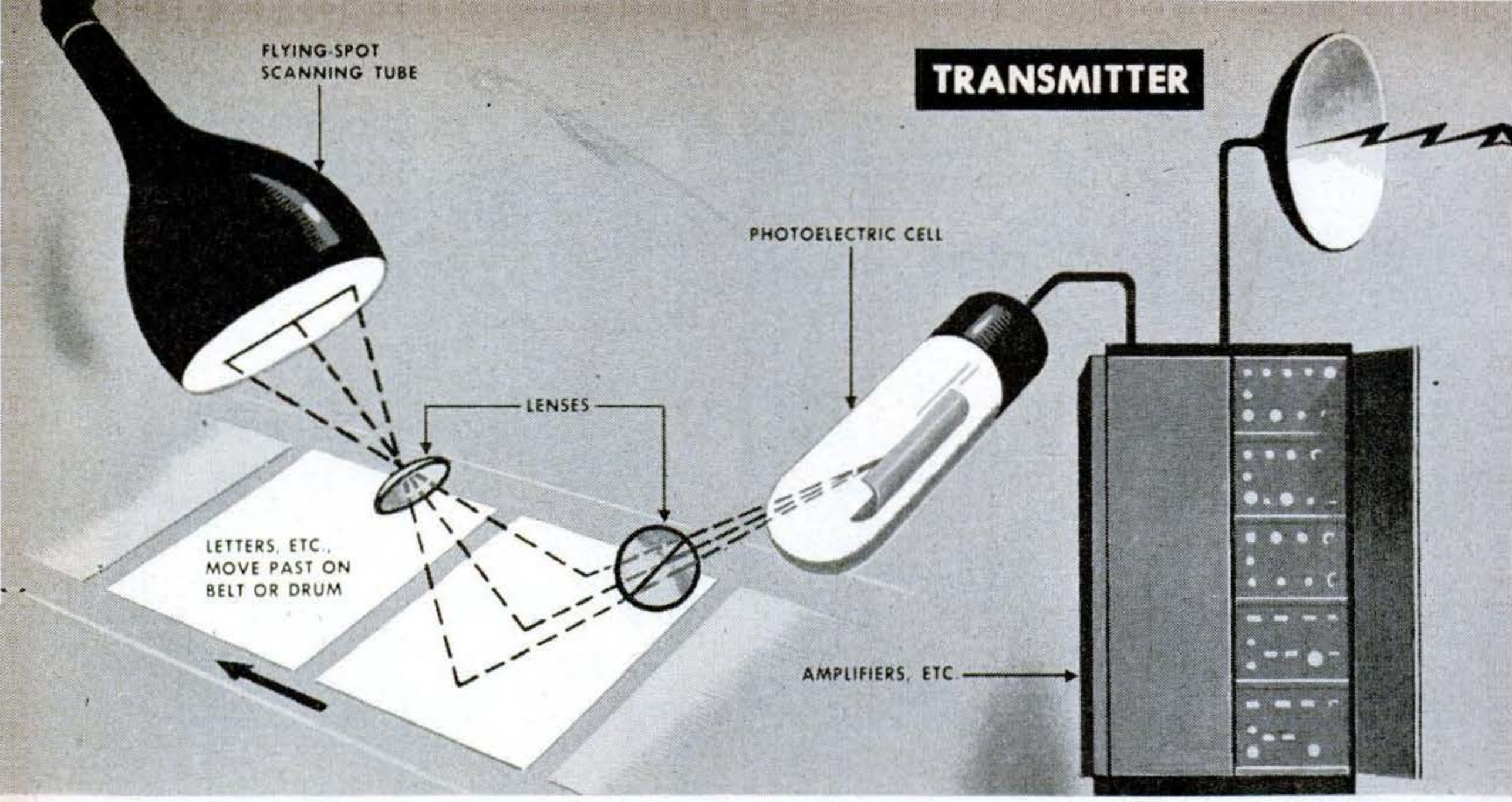
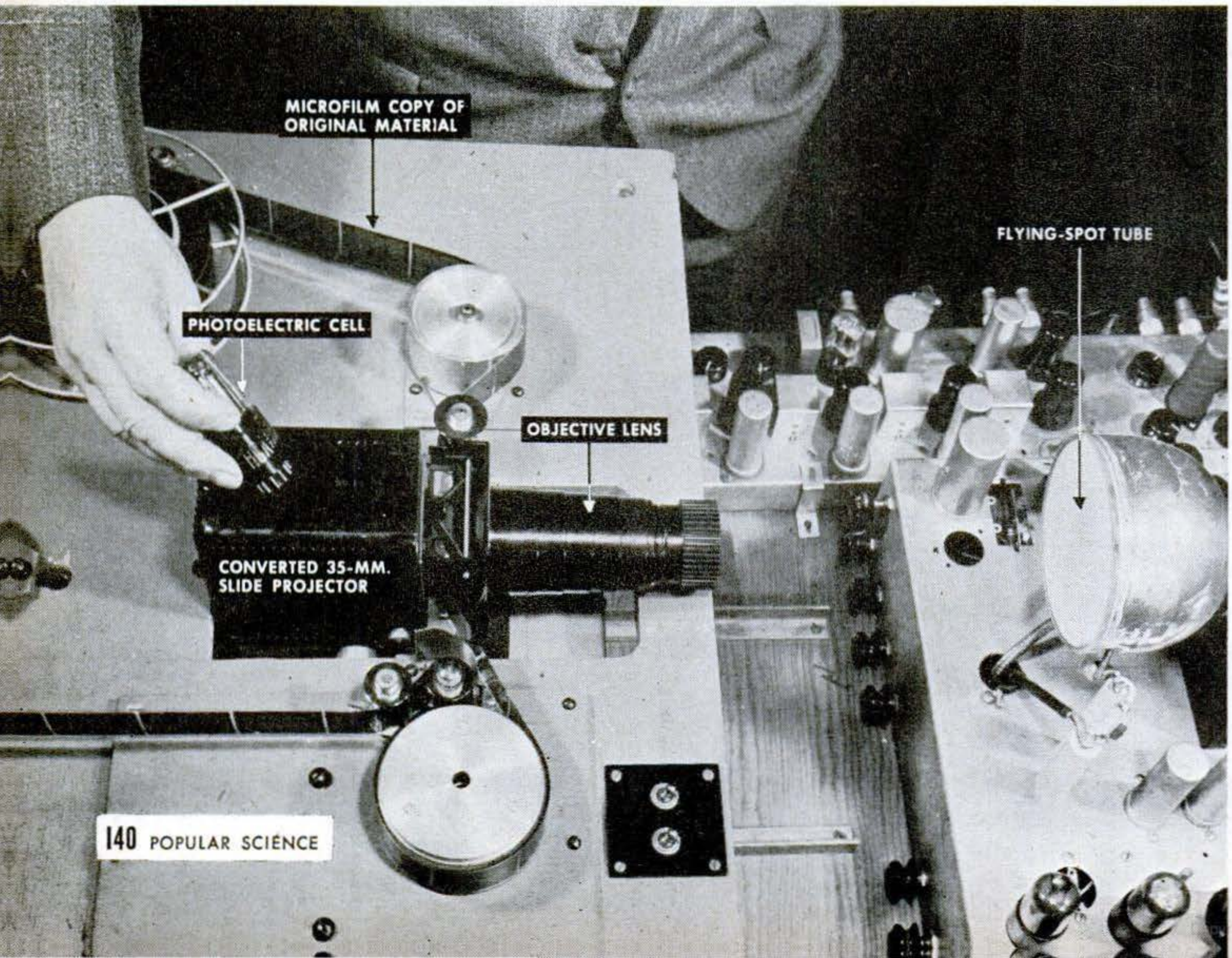


In commercial use, scanning tube will convert written material, carried on high-speed belt or drum, directly into electrical impulses, without microfilm step now used in experimental model.

Ultrafax® transmitter (below) has flying-spot scanning tube at far right. Rapidly moving spot of light on its face is focused on microfilm by objective lens of converted slide projector, then passes through to photoelectric cell (in engineer's hand). Photocell converts variations of light and dark into electrical impulses that are transmitted like television. Scanning tube serves only as a source of light, having a very tiny spot of light that moves very fast in one direction—horizontally relative to the written material. The material itself provides vertical motion. This arrangement makes for continuous operation, with no individual "frames" as in television. Viewing tube and camera in the receiver are synchronized with the transmitter.



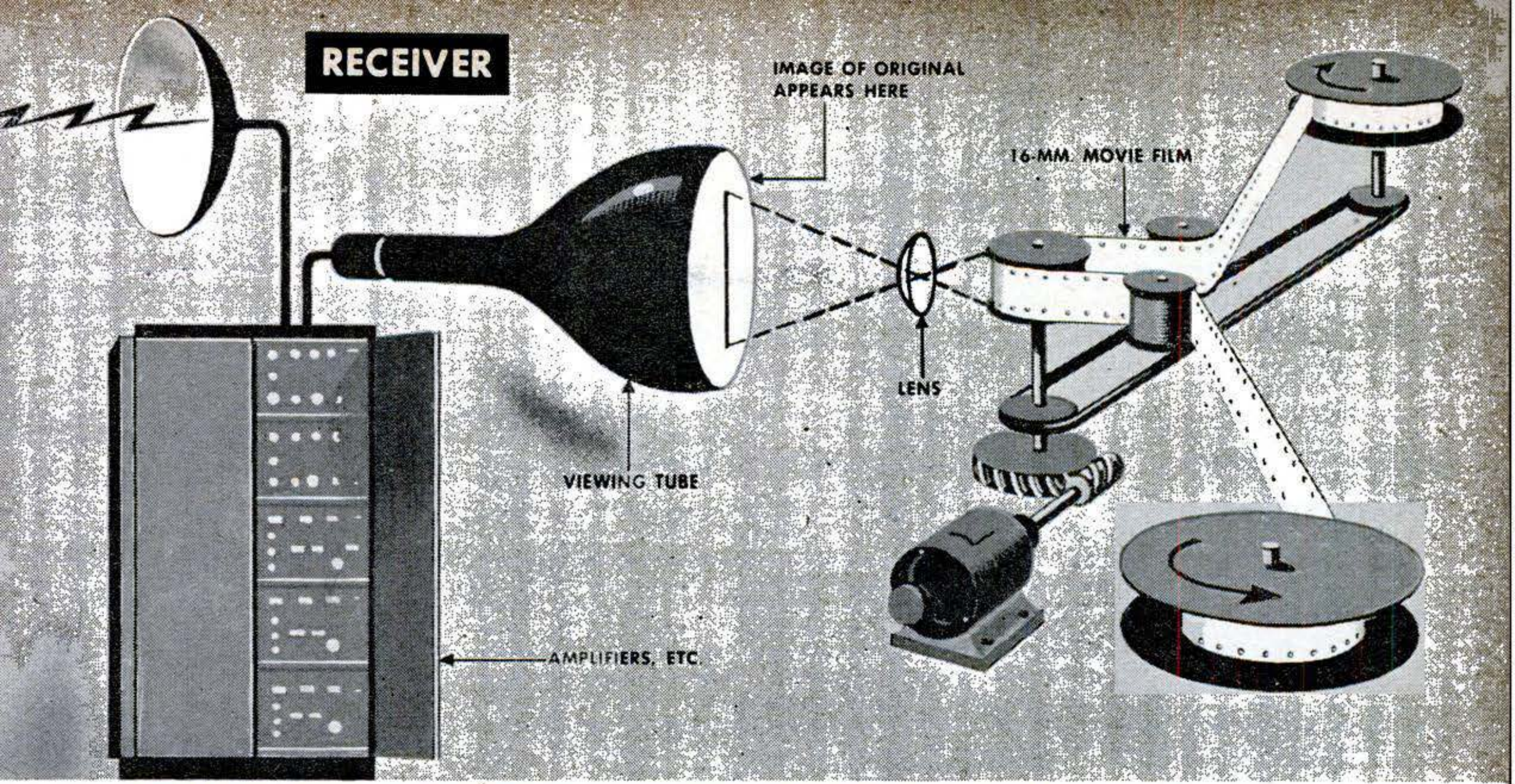


Image on viewer is photographed on 16-mm. movie film, which eventually will run straight through developing and printing machines, giving fast, automatic duplication of the original.

How Ultrafax Works

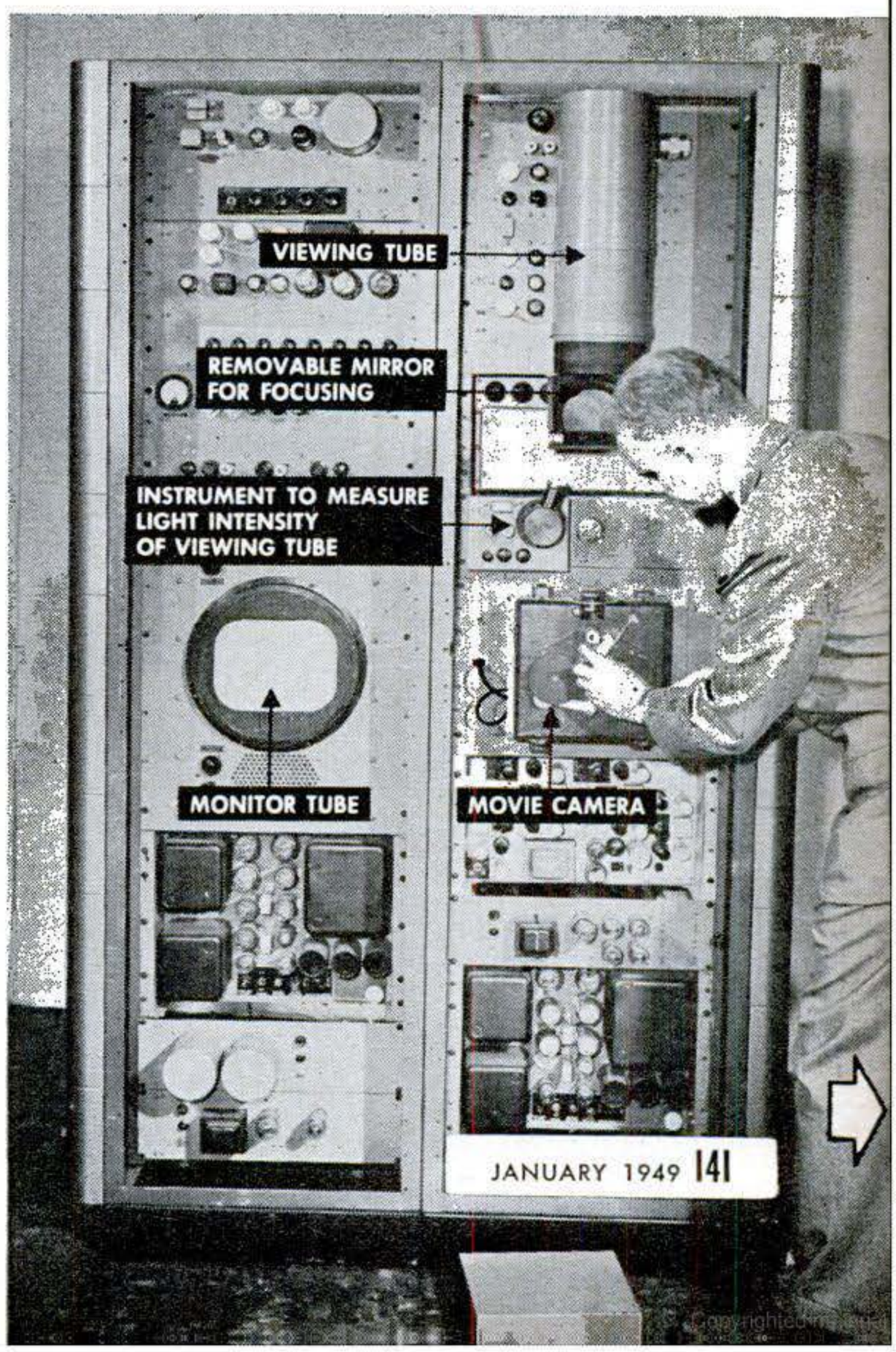
High-speed facsimile system can send tons of mail, complete newspapers over ultra-short waves in few minutes.

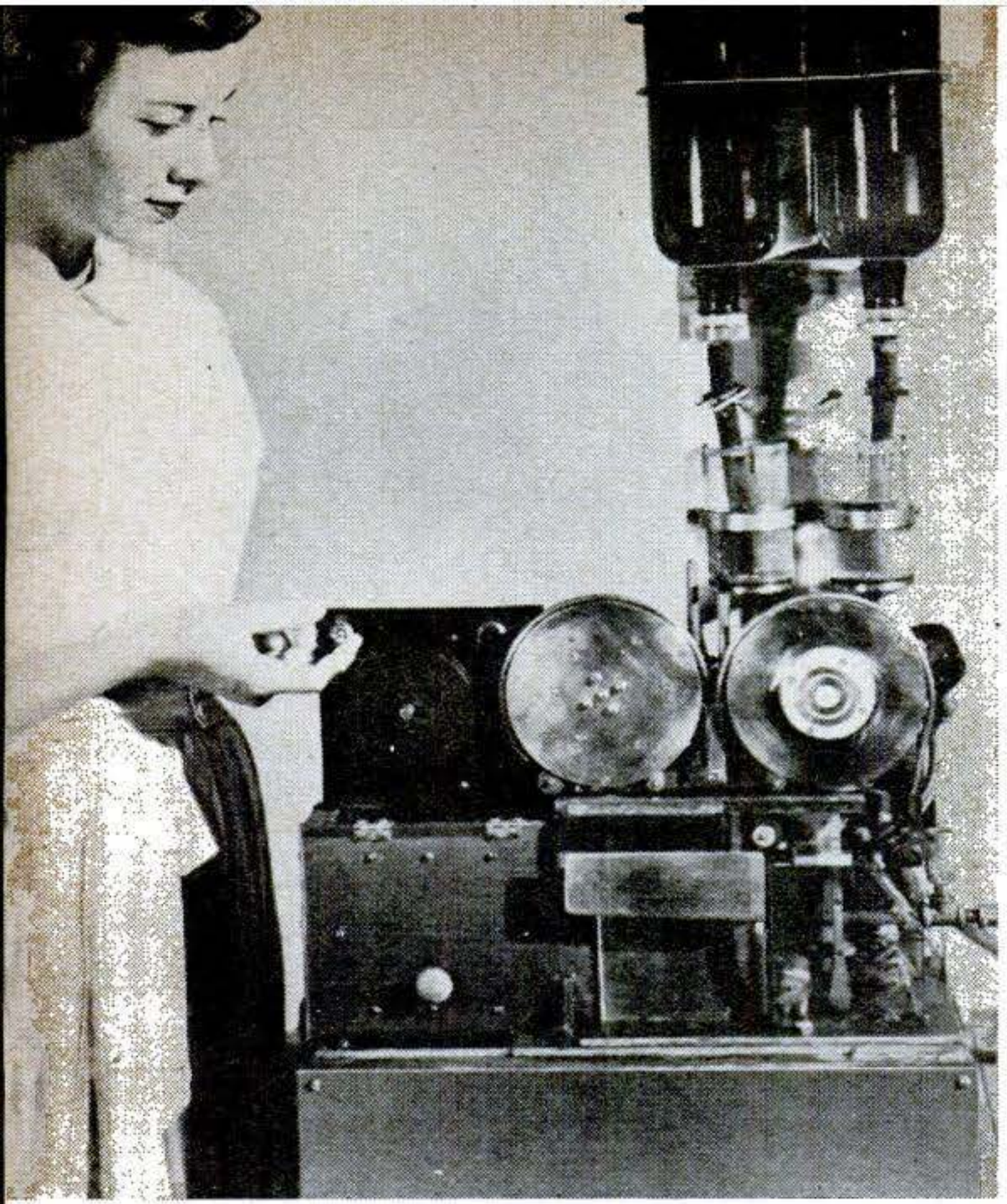
ULTRAFAX ® is out of the laboratory. This combination of television and photography, promising to provide a million-words-a-minute radio mail service (PS, Nov. '47, p. 94), showed its stuff at a recent demonstration in Washington.

The experimental system—developed jointly by RCA, NBC, and Eastman Kodak—televises letters, books, or any other documents to a distant receiver. Here the image is recorded on 16-mm. film and then duplicated like wartime V-mail.

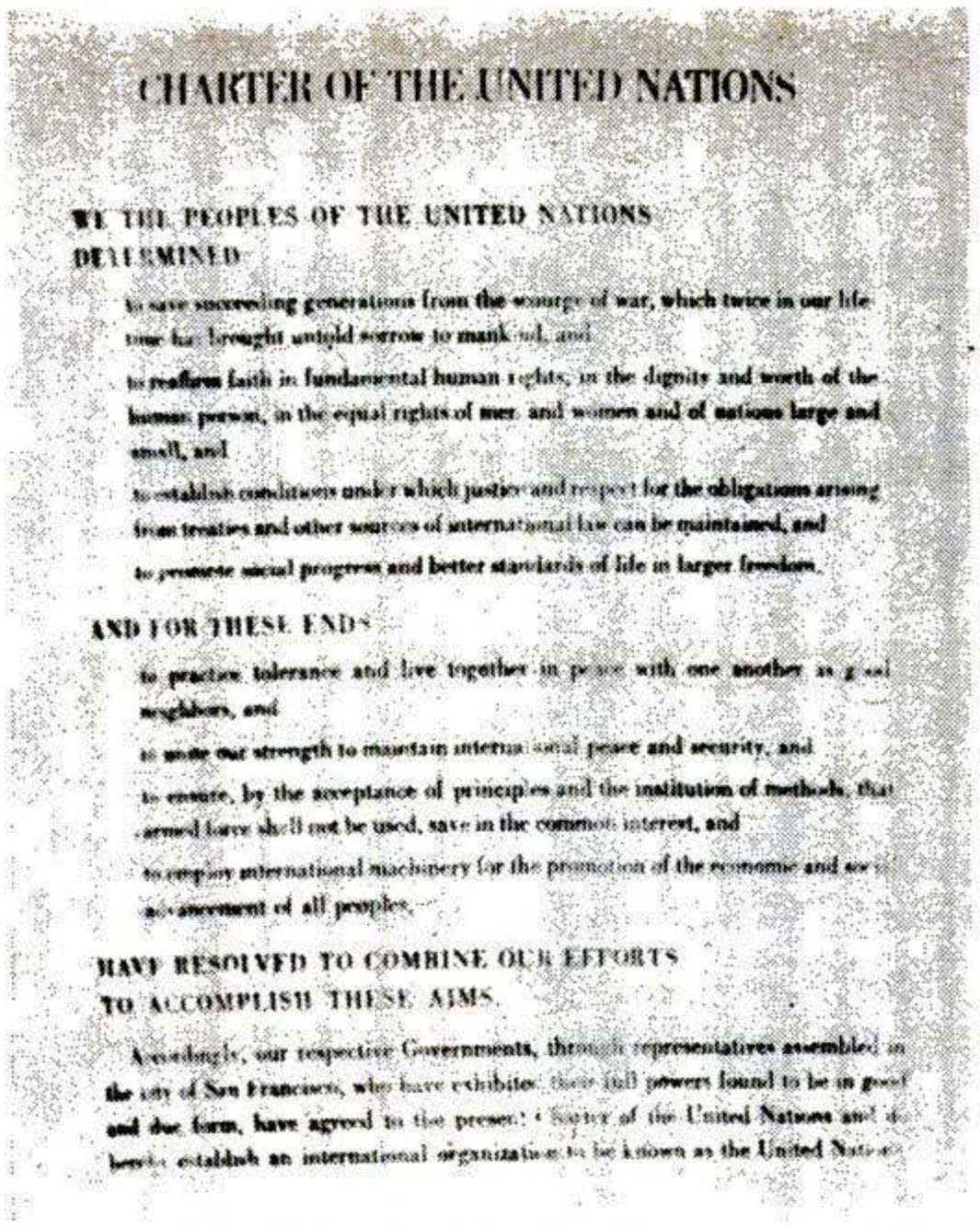
The present laboratory setup transmits from a microfilm record at about 500,000 words a minute. The range of frequencies now used—a standard television band—sets this limitation. With wider bands expected to be available when the very short wavelengths are opened up for television, twice this speed could easily be obtained.

Ultrafax receiver (below) picks up signals from transmitter and displays them on viewing tube, which reproduces light-and-dark pattern. This image is recorded by movie camera, into which engineer is shown loading film. Film in this camera moves continuously in time with microfilm in transmitter. Angled focusing mirror under viewing tube is removed in operation.





Reproduction of the original messages keeps pace with the high speed of Ultrafax transmission by using new processing methods. Machine shown above, made by Eastman Kodak, develops, fixes, washes, and dries the negative in 40 seconds. It achieves this speed by using extremely active, hot chemicals and applying them only to short lengths of the film at a time.



CHARTER OF THE UNITED NATIONS

WE THE PEOPLES OF THE UNITED NATIONS
DETERMINED

to save succeeding generations from the scourge of war, which twice in our lifetime has brought untold sorrow to mankind, and

to reaffirm faith in fundamental human rights, in the dignity and worth of the human person, in the equal rights of men and women and of nations large and small, and

to establish conditions under which justice and respect for the obligations arising from treaties and other sources of international law can be maintained, and

to promote social progress and better standards of life in larger freedom,

AND FOR THESE ENDS

to practice tolerance and live together in peace with one another as good neighbors, and

to unite our strength to maintain international peace and security, and

to ensure, by the acceptance of principles and the institution of methods, that armed force shall not be used, save in the common interest, and

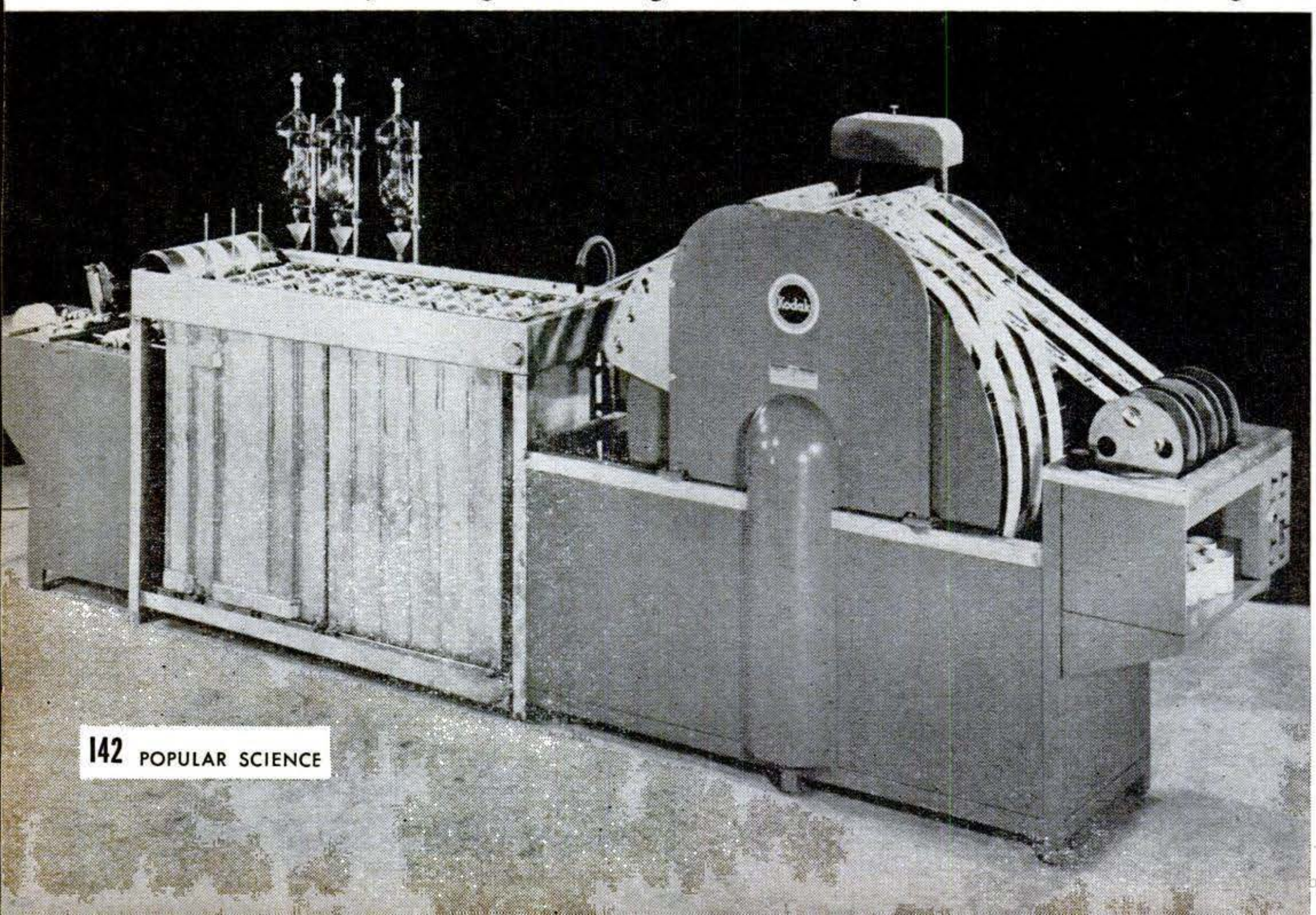
to employ international machinery for the promotion of the economic and social advancement of all peoples,

HAVE RESOLVED TO COMBINE OUR EFFORTS
TO ACCOMPLISH THESE AIMS.

Accordingly, our respective Governments, through representatives assembled in the city of San Francisco, who have exhibited their full powers found to be in good and due form, have agreed to the present Charter of the United Nations and do hereby establish an international organization to be known as the United Nations.

An exact, photographic duplicate of original material is the final product of Ultrafax. The sample shown above is a copy of the Charter of the United Nations after actual transmission during a demonstration in Washington. Anything else could be handled as easily—handwriting, drawings, printing in any kind of type or language, photographs, even complete movies.

After the negative has been developed, it is enlarged to make sizable prints in much the way wartime V-mail was reproduced. The enlargements are developed on a high-speed machine (below), called a continuous-paper processor. Donald S. Bond, RCA engineer in charge of Ultrafax research, visualizes an interconnection between receiver and the two machines on this page, so that reels of film need not be moved from one to another and operation will be completely automatic. Messages all ready for delivery will shoot out the receiving end.



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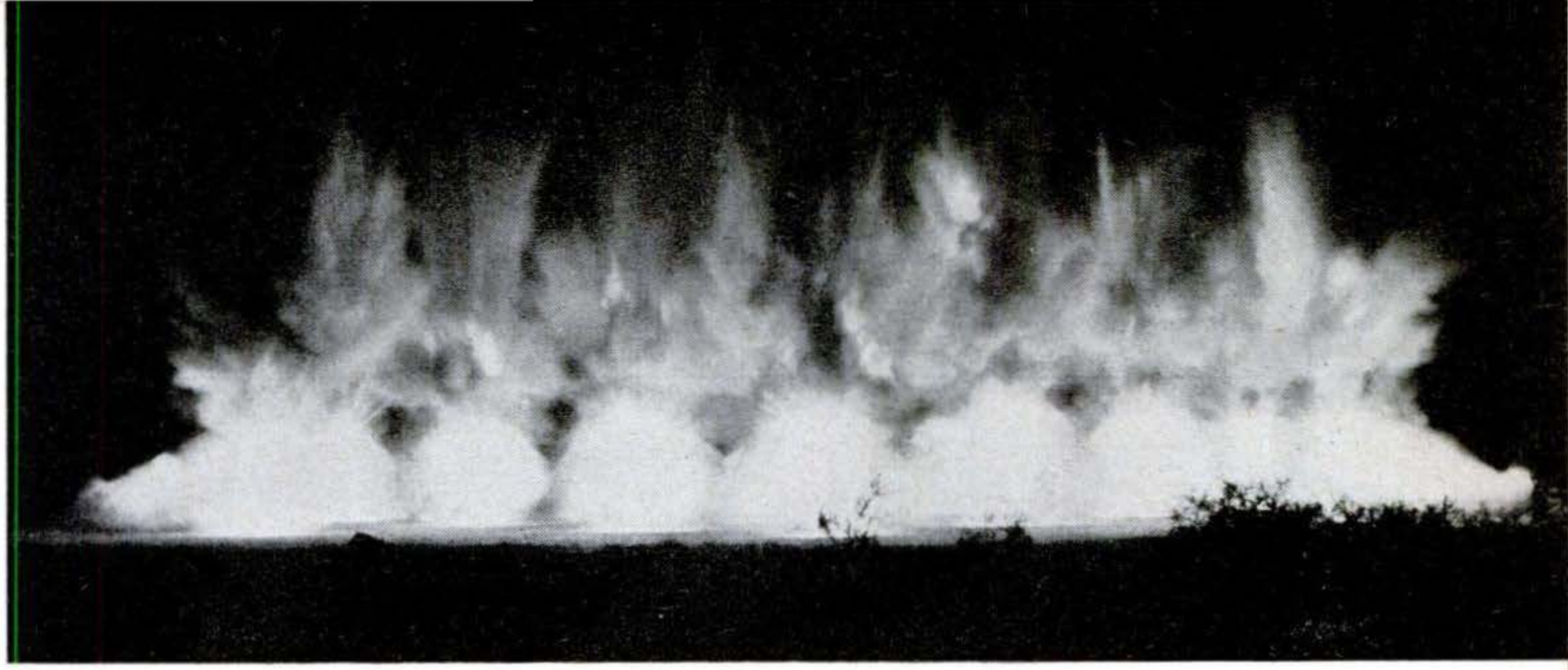
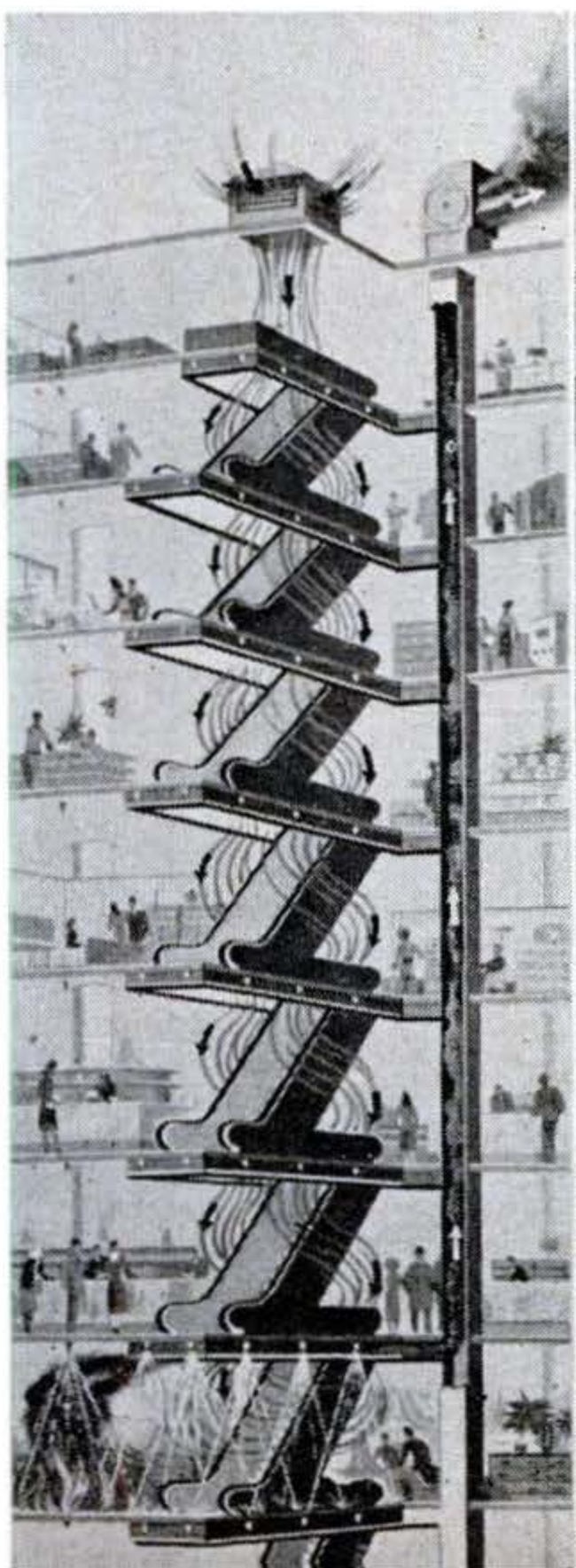


"Fireworks" Find Oil

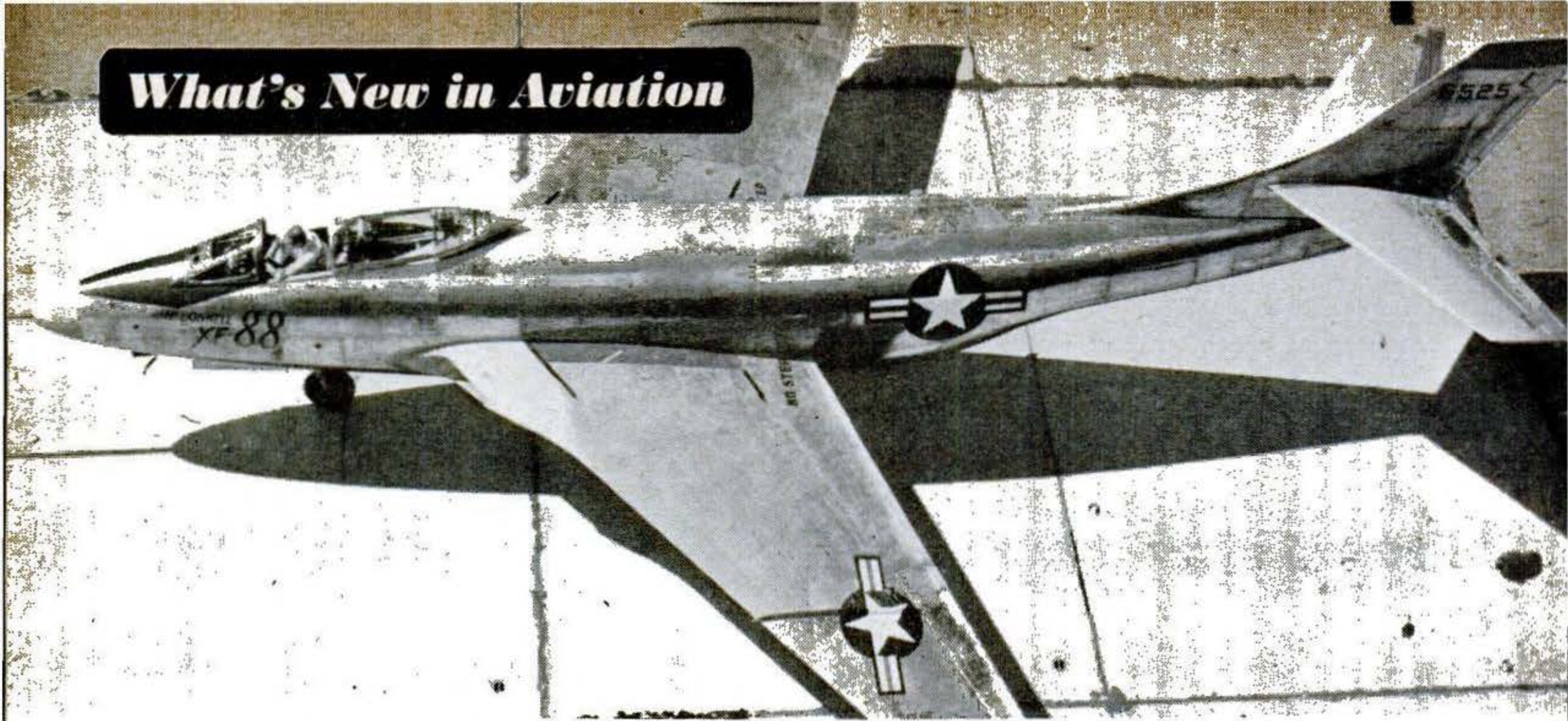
THIRTEEN explosive charges set off at once, on stakes in a hexagonal pattern, gave the pyrotechnic display above. It demonstrated a time-saving and economical new way to make artificial earthquakes, for underground mapping. Now used in prospecting for oil, it was developed by Dr. Thomas C. Poulter of Stanford Research Institute. Instead of firing one heavy charge in a hole below ground, the Poulter method eliminates drilling but uses the same recording devices. Seven to 19 light charges are exploded in the air. The secret lies in their design and arrangement.

Fan Fights Fire

PS printed the drawing below more than a year ago (Sept. '47, p. 132) in reporting a new plan to prevent fires from leaping up escalators. It shows a fan sucking smoke out through an exhaust duct as a downdraft in the escalator shaft keeps flames and gases from upper floors. Now such a system, set off by Kidde photoelectric smoke detectors, has been installed in the Allen-Sage store in Hartford, Conn. The photo at right below, taken during a test, shows how the forced draft makes smoke billow down the open escalator shaft instead of up. Westinghouse designed the exhaust equipment.



What's New in Aviation



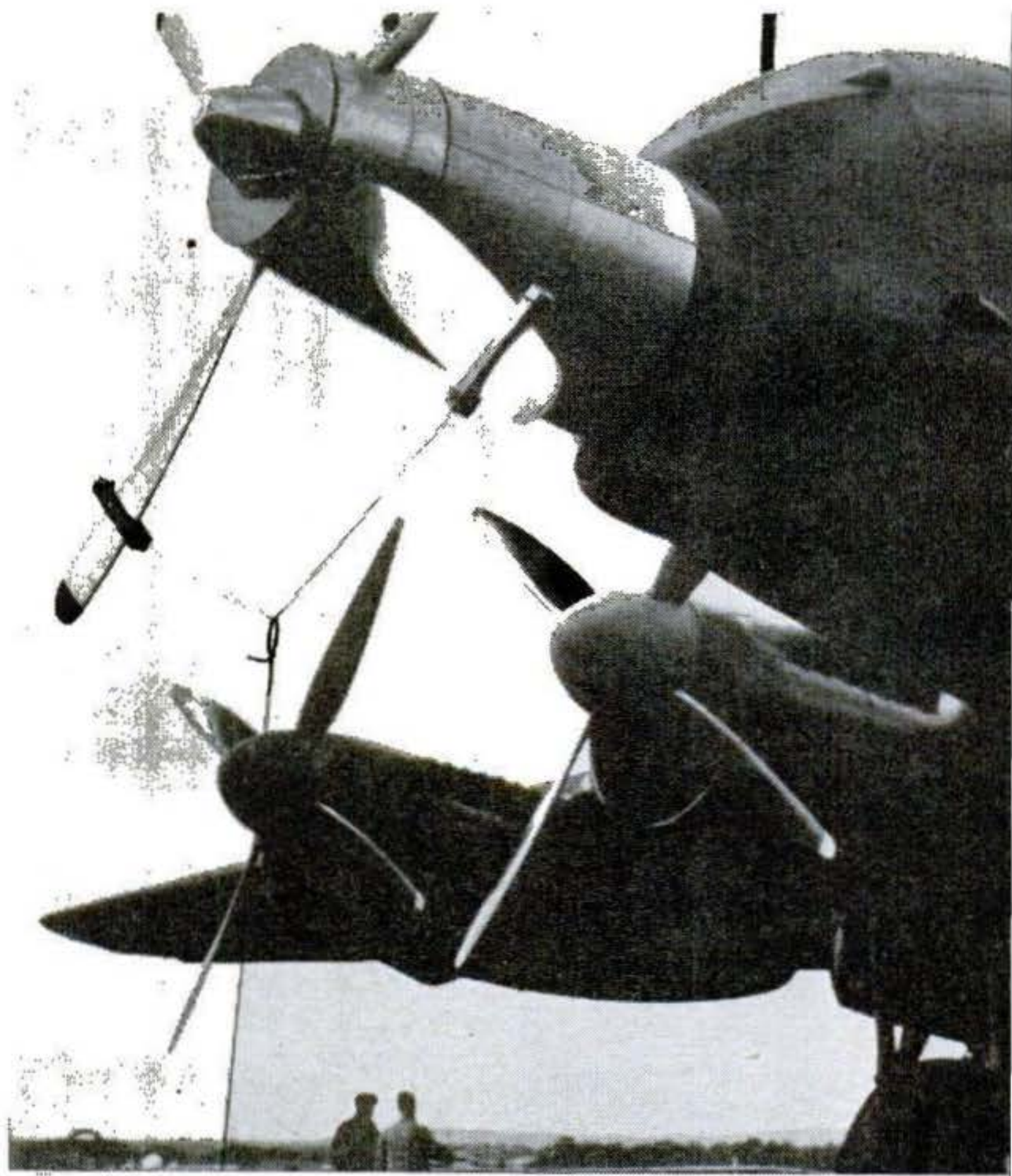
Designed for Penetration. The Air Force has assigned this arrow-shaped speedster, the new McDonnell XF-88, the double duty of operating deep inside enemy territory as either a fighter-bomber or a bomber escort. Powered by twin jets, it is a single-seater, 55 ft. long, with a wing span of 40 ft. Its gross weight is 15,000 lb.

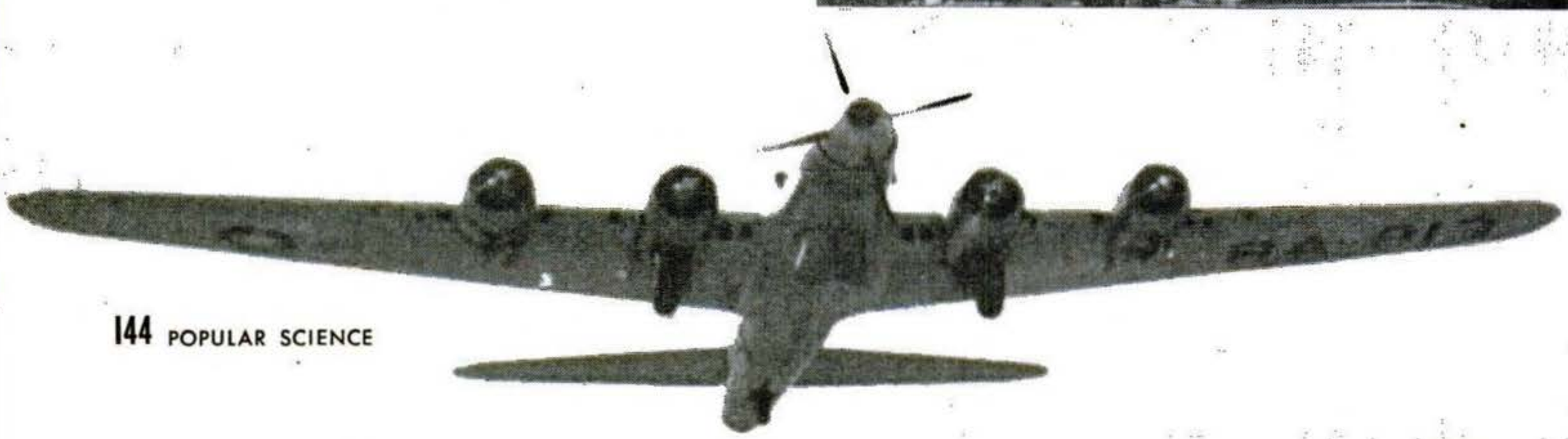
Bombers Try Fifth Prop. These odd-looking five-engine bombers are flying laboratories for testing powerful turboprop engines that drive big propellers added to their noses. A British Avro Lincoln, at right, has been fitted with a Naiad turboprop engine; a B-17, below, with the new T-35 Typhoon, developed for the Air Force by the Wright Aeronautical Corp.

This method of testing makes it possible to study engine, propeller, and nacelle at the same time under flight conditions.

To accommodate the huge Typhoon engine, housed in what was formerly the bombardier's compartment, the cockpit of the B-17 was moved back four feet, the nose extended, and the fuselage completely reinforced.

The new engine drives a Curtiss electrical propeller. This combination, though not capable of jet speeds, increases the plane's range. The engine's power output, lubrication, and fuel consumption have been subjected to rigid flight tests. The results, however, are being withheld by the Air Force.





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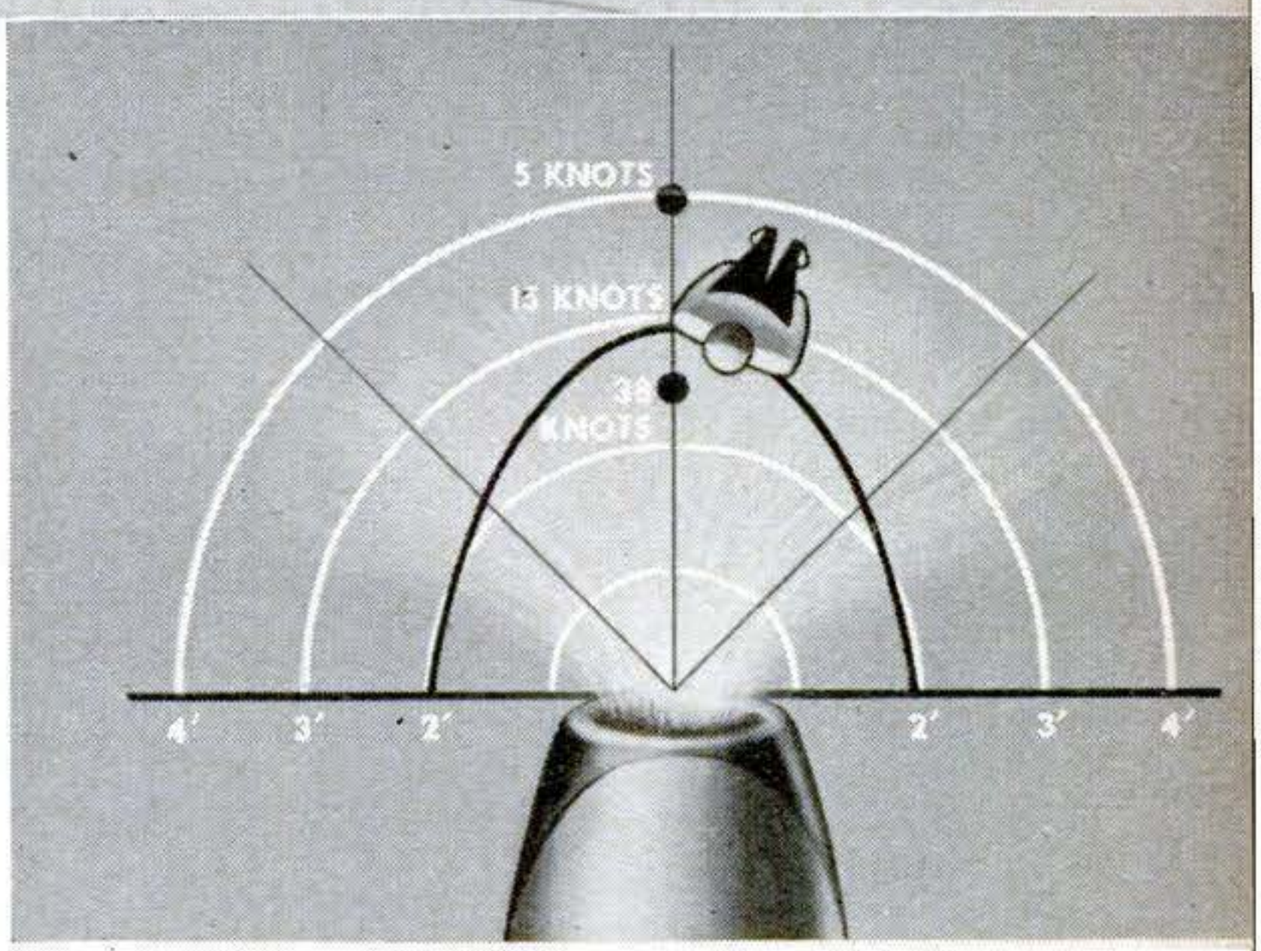
Jets Can Suck You In. With a safety line attached to his parachute harness, the Navy lieutenant above walked up to the intake of an FJ-1 Fury with its jet-engine going at full power. Object of the test was to see how close a person can get without danger of being swallowed by the powerful suction.

This experiment, at the Naval Air Test Center, Patuxent, Md., showed the danger limit to be from two to five feet. The chart at right shows how suction falls off as the distance increases from the front end of the jet. The Navy warns, however, that heavy flight clothing will help "blow" a person in.



British Glider Gets Power. The Slingsby Motor Tutor® (below) was born from a glider. Design changes to make an airplane of it included raising the wing eight inches, rebuilding the nose to accommodate a 37-hp. Aeronca engine, and replacing the landing skid with a conventional undercarriage. The plane cruises at 60 m.p.h., has a range of 200 miles, and can be looped or perform stall turns. Though the cockpit is open, the pilot is protected by a windshield. The plane is designed to sell at a low price and is said by the manufacturer to have proved safe and easy to fly.

New Look for Pilots. The amber Plexiglas® shield worn by the pilot at left below lets him practice blind flying in a plane with an ordinary canopy. In combination with blue goggles, it filters out all light. The wearer can look under the shield and read his instruments, but he can't see outside. The gear was devised by a Marine sergeant at Cherry Point, N. C.

The goggles worn by the Air Force pilot at right below have a de-fogging device. The end of the rubber tube he is holding is placed outside the cockpit in flight and picks up cool air to keep the goggles clear.

Radio Telescope Creates

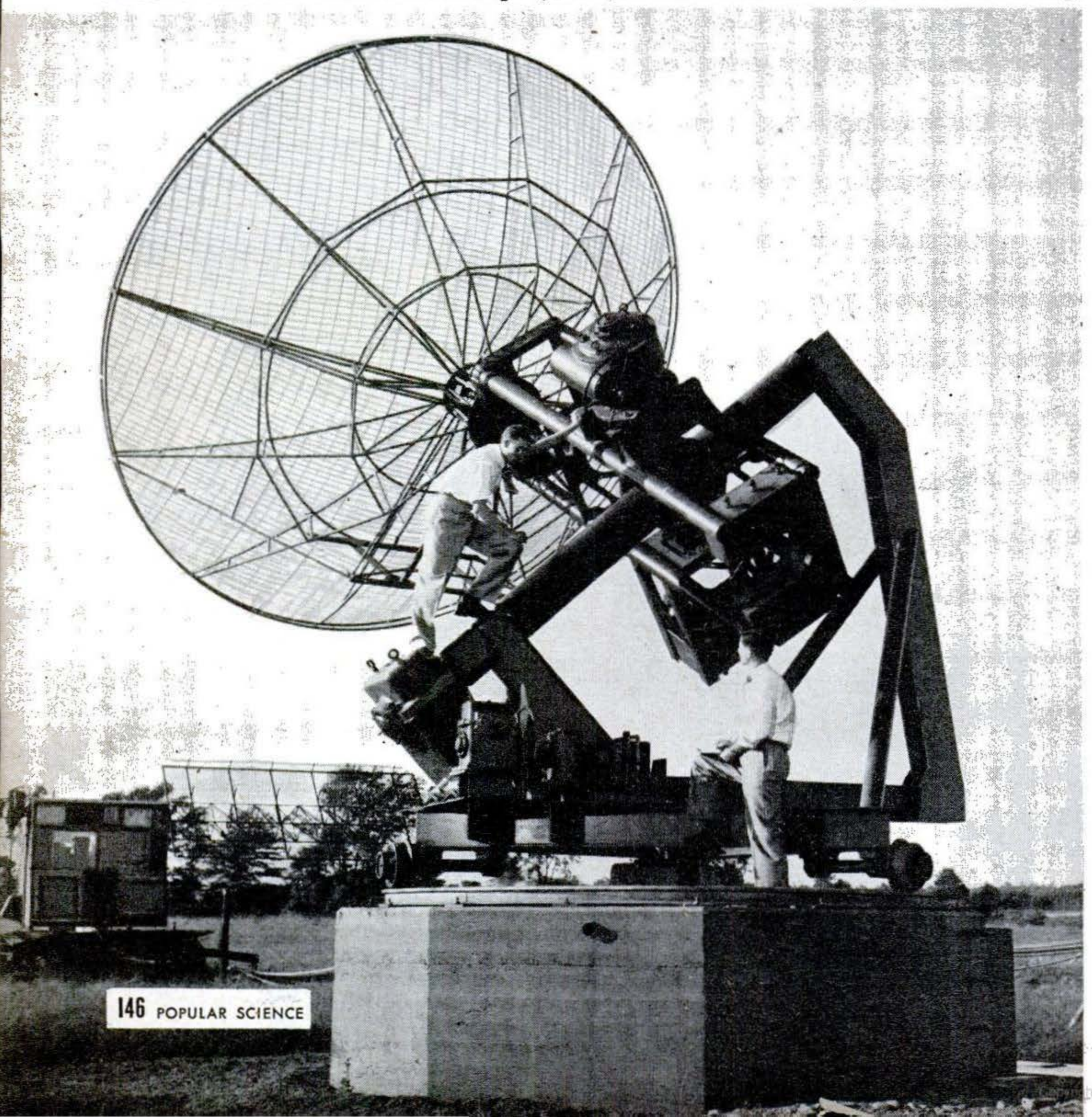
Burps and hisses from parts of sky where nothing can be seen may clear up other mysteries.

SOME of these days, a college catalogue may list a course like this:

> RADIO ASTRONOMY. Fall term. Credit three hours. Mr. Whosis. The technique of receiving, recording, and interpreting radio broadcasts from the sun and stars, and the exploration of the invisible parts of the universe.

Soldiers and fliers, as well as astronomers and dreamers, may study this new science. In their telescopes, amplifying tubes will serve as lenses, wire screens as mirrors, and sounds instead of sights will be recorded. These radio telescopes, which look like radar apparatus, will cost less than optical tele-

No dome shields Cornell's new telescope (below). It is built for listening rather than looking.



New Science

By Volta Torrey

scopes but may be far more useful. They are being developed now.

But no college has offered a course in radio astronomy yet, because this science is too new. Its founders are still uncertain how to talk to each other.

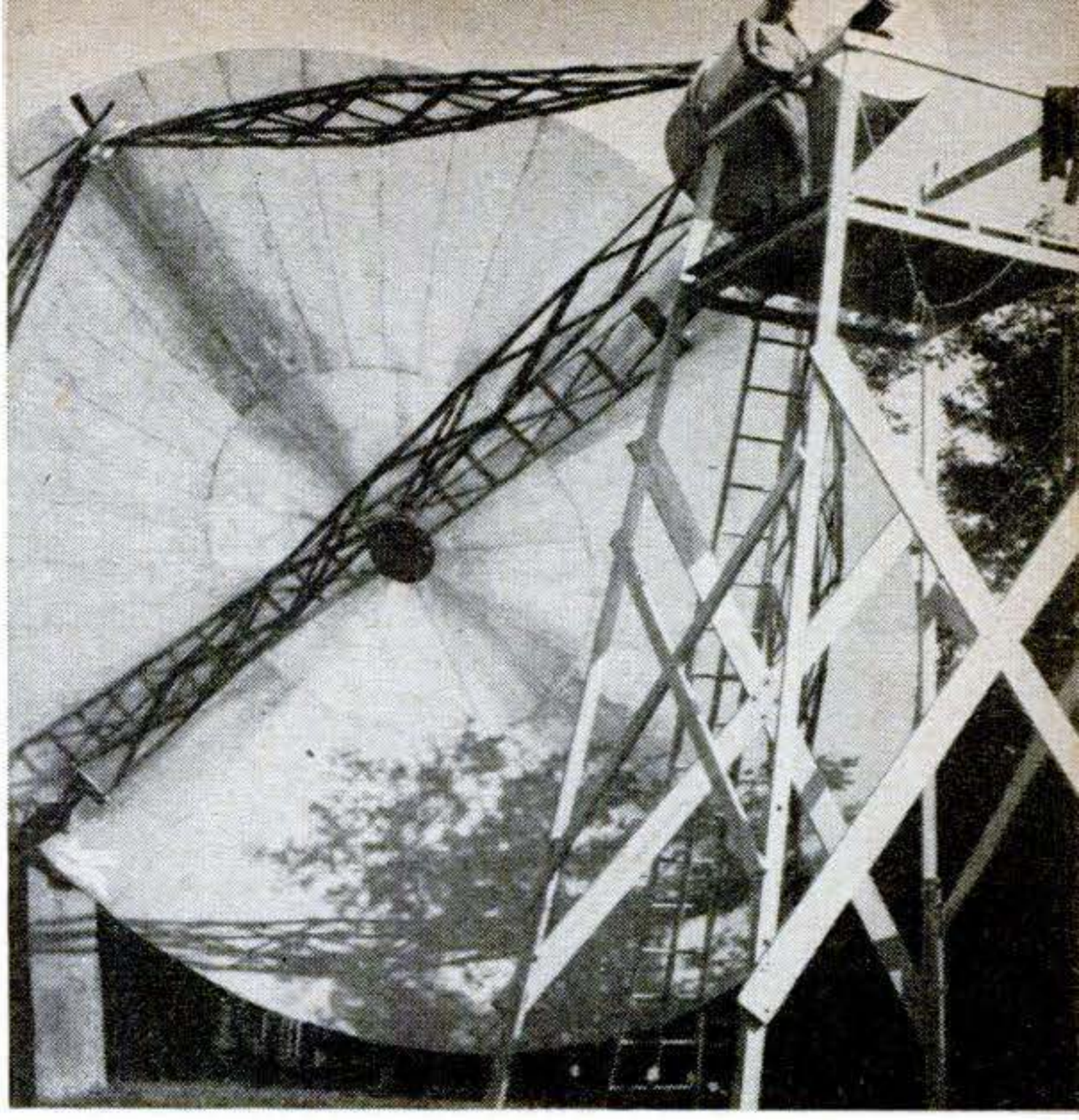
Should they continue to call the noises that come out of their radio telescopes "burps," "hisses," "bursts," "swishes," "grinds," etc.? Or should they coin new, more precise terms? Or should they identify the various sounds by numbers or letters? A committee to ponder this urgent problem was appointed recently when the pioneers in radio astronomy conferred at Cornell University.

Cornell is the first American university to build a radio-astronomical observatory. Two other U. S. stations, three in England, three in France, one in Canada, and one in Australia are also trying to decipher the chatter of the sun and stars. The Russians may be listening in, too.

The Australians have found that even parts of the sky in which nothing can be seen are making noises. How? And why? Nobody knows.

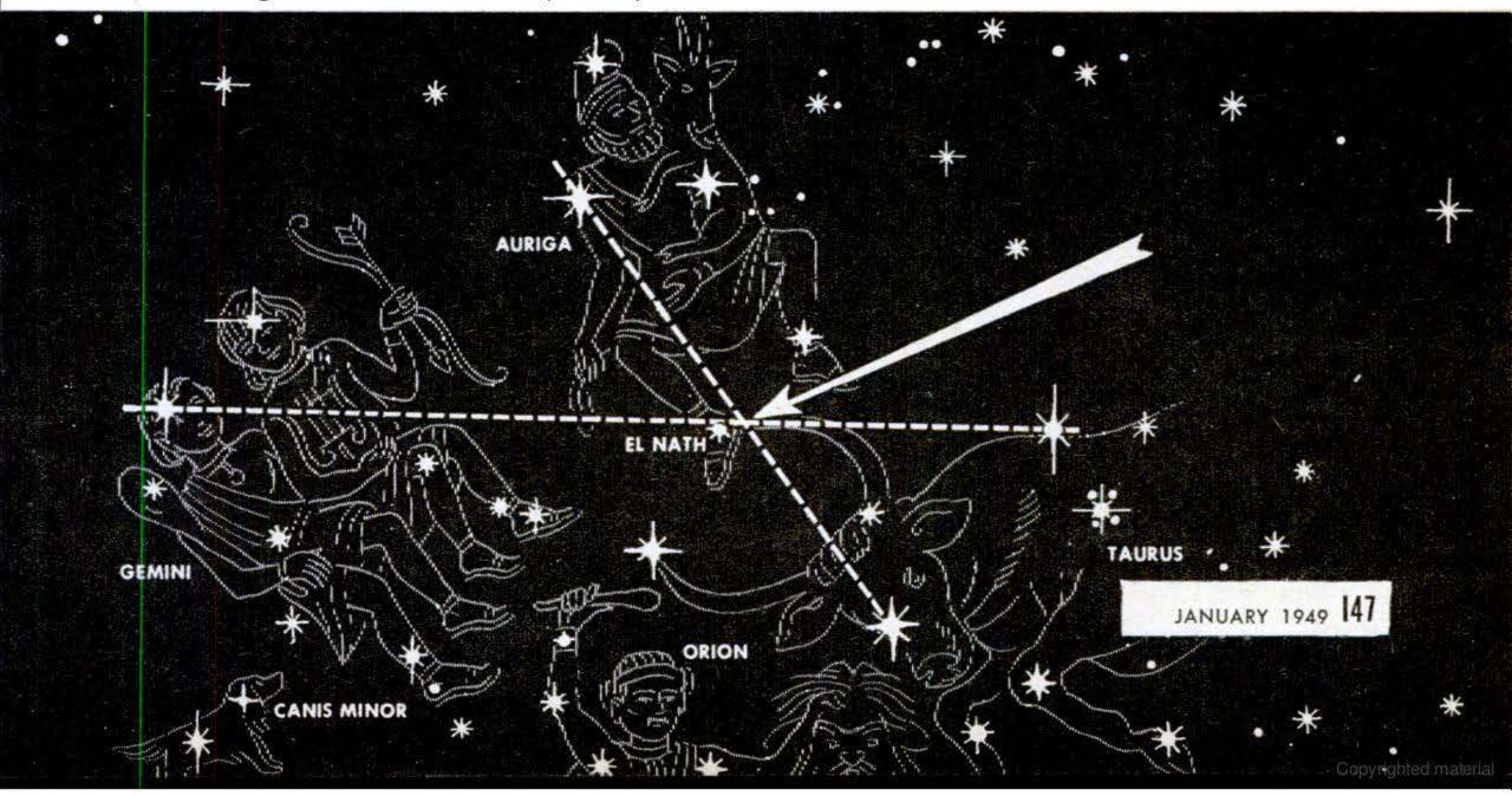
"This business," says one of the young engineers at Cornell, "gives a fellow a good idea of how Galileo must have felt."

You don't have to be much of a seer, however, to see that more knowledge of radio astronomy might be very helpful, pronto.



This picture of one of the first radio telescopes appeared in PS a year ago (Jan. '48, p. 150). It was built by Grote Reber, a ham from Wheaton, Ill., now a Bureau of Standards radio physicist. Note how different it looks from new Cornell model on facing page.

You can see for yourself that there's nothing to see at one of the points from which radio astronomers have heard noises. Step outside any clear night and find El Nath (below). The area just west of this star is one of those points. Between 9 and 10 p.m. at this time of year, El Nath is slightly to the south of a point overhead for most observers in the United States.



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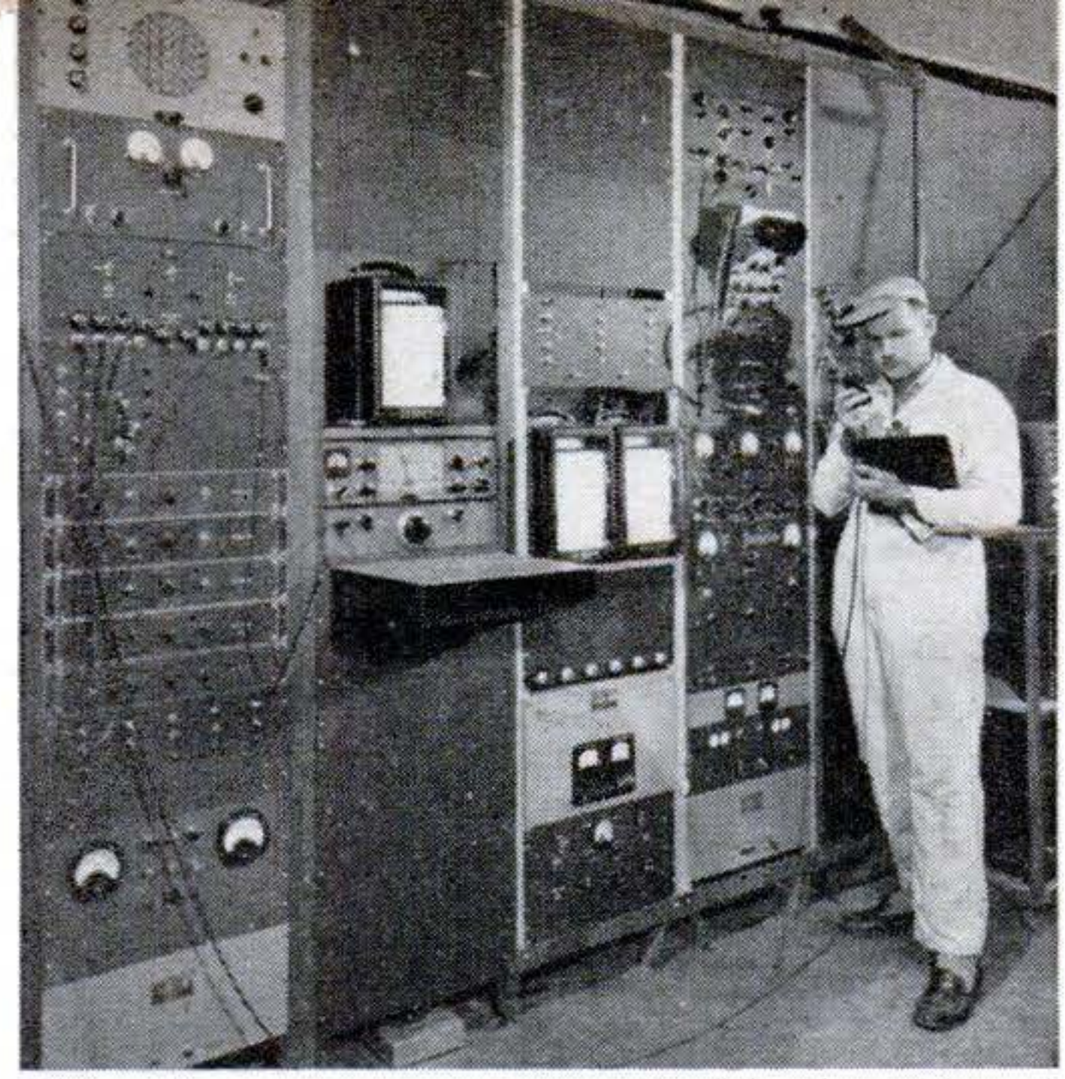
On a celestial globe, Prof. Charles S. Seeger indicates to William E. Gordon (left) the Saggitarius region, which produces the strongest radio "noise" broadcast from the Milky Way.



Noise from stars comes out of loudspeaker at top left in Cornell radio-astronomical observatory. Sound variations too small to hear are recorded on rolls of paper in center of board.

Suppose, for example, that some nation were planning a long-range bombing attack. The results would depend pretty largely on the performance of radio and radar apparatus. That, in turn, would depend on the sun. It shoots out particles that disturb the ionosphere from time to time, and those disturbances raise hob with radio and radar systems.

But the sun also broadcasts sounds that the radio telescopes pick up. These radio waves span the 93,000,000 miles from the sun to the earth as fast as light—and arrive several hours ahead of the particles that make the ionosphere play tricks on the communications experts.

Are the radio waves warning signals from the sun? Can they be interpreted? Will they tell us when our radars will work and when they won't?

When put on a loudspeaker, the broadcasts from the sun make it hiss and occasionally pop. When recorded on a moving strip of paper, these sounds produce a long, kinky line. That sound track may some day be as helpful to communications engineers as an animal's tracks are to a hunter.

But, to learn to read this kind of writing, the scientists need continuous records of the sun's broadcasts. These cannot be compiled by any one receiving station: three or four stations on different sides of the world will have to cooperate. Each one will have to focus its antenna on the sun for so many hours, then pass the assignment on to the next station like a runner in a relay race. Timing, apparatus, and methods of comparing findings must be agreed on beforehand.

The new radio telescope at Cornell works very much like a big optical telescope. The reflector of this hearing aid is 4 inches wider than the 200-inch mirror of the big "eye" on Mt. Palomar. This sound mirror, however, is transparent. It is simply a wire screen, shaped like a saucer. This screen focuses the radiation from afar on a tiny antenna that protrudes from the center of the dish.

The big saucer and antenna are mounted so that they can be kept directed at the sun, a star, or a "ghost" broadcasting area while it crosses the sky. The ear turns automatically, the same way that big optical telescopes track the objects they wish to keep in view.

There are two definite advantages to listening to the stars through such an ear, rather than looking at them through optical lenses. The radiation that the radio telescopes pick up extends over three times as much of the electromagnetic spectrum as does visible light. This means, in effect, that it's possible to hear what's happening in the heavens through a window three times as big as the one that we see through. The second wonderful thing about this radiation is that it is not shut out, the way the light from the stars is, by passing clouds. This means that radio telescopes can be used on the darkest, stormiest night. The one at Cornell is built to withstand winds up to 60 miles an hour.

Moreover, Cornell's big ear cost only one-half of one per cent as much as California's big eye. Which will prove to be the better investment depends on what the stars are saying and how soon the scientists learn their language. END

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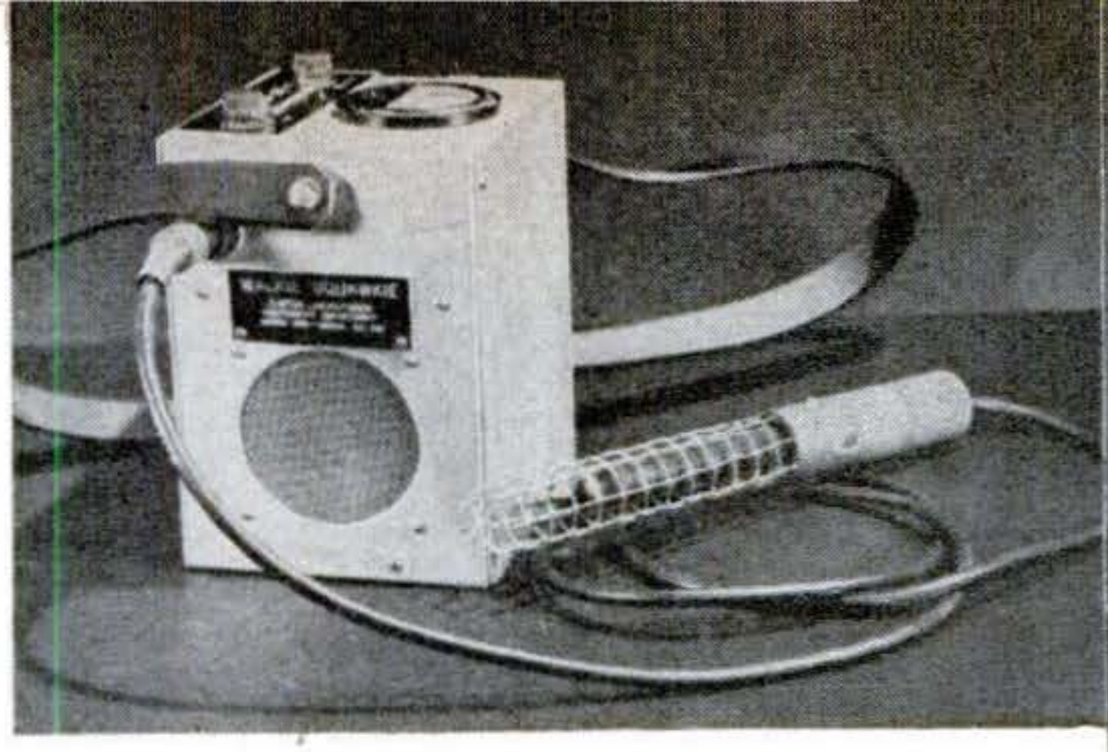
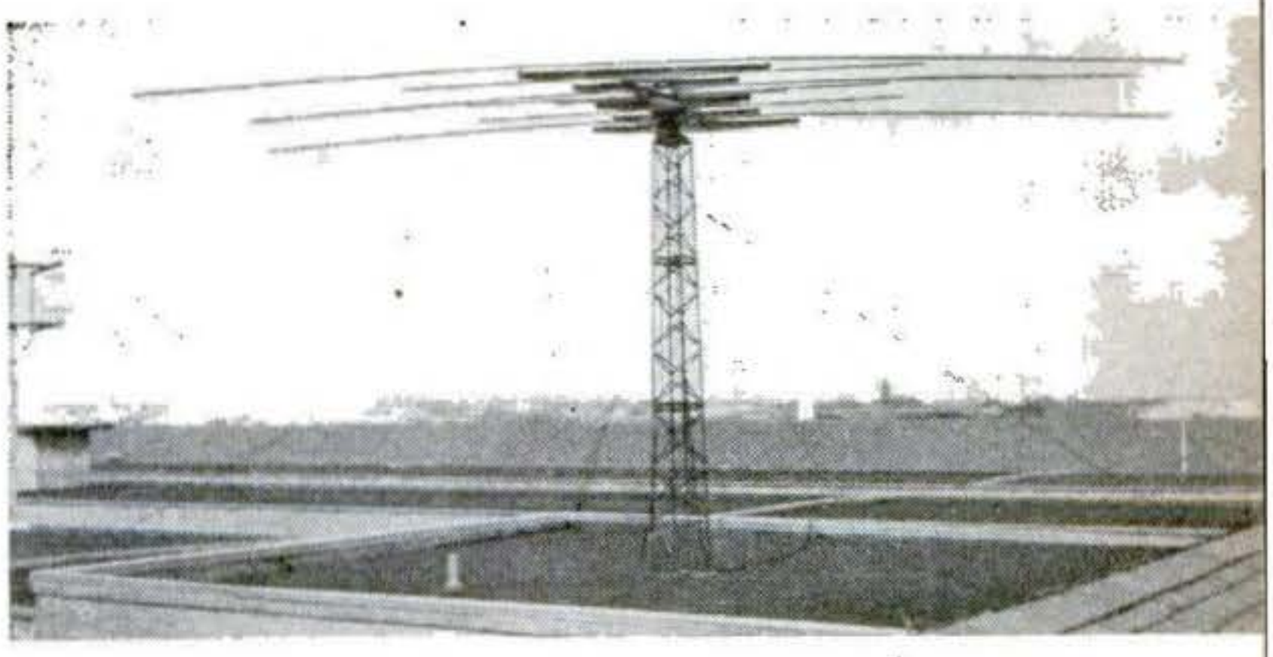


Rays Trip Tiny Traps

THESE two instruments now aid the hunt for new facts about the atom. In the Walkie-Squawkie (above), developed at Oak Ridge, a loudspeaker clicks when gamma or beta rays hit a probe on the end of an extension cord. At right is a new Westinghouse neutron counter in which a photoelectronic tube registers explosions of uranium-235 atoms split by neutrons that penetrate two inches of paraffin lining a metal can.

Army Contacts "Hams"

THE radio antenna at right, on top of the Pentagon Building in Washington, is part of the Army's new "ham" station, K4USA. Its operation, on amateur-broadcast bands, is aimed at encouraging the development of a reserve of experienced communications personnel for the military services. The three-element, 10- and 20-meter, rotary-beam antenna is mounted on an 18-foot tower.

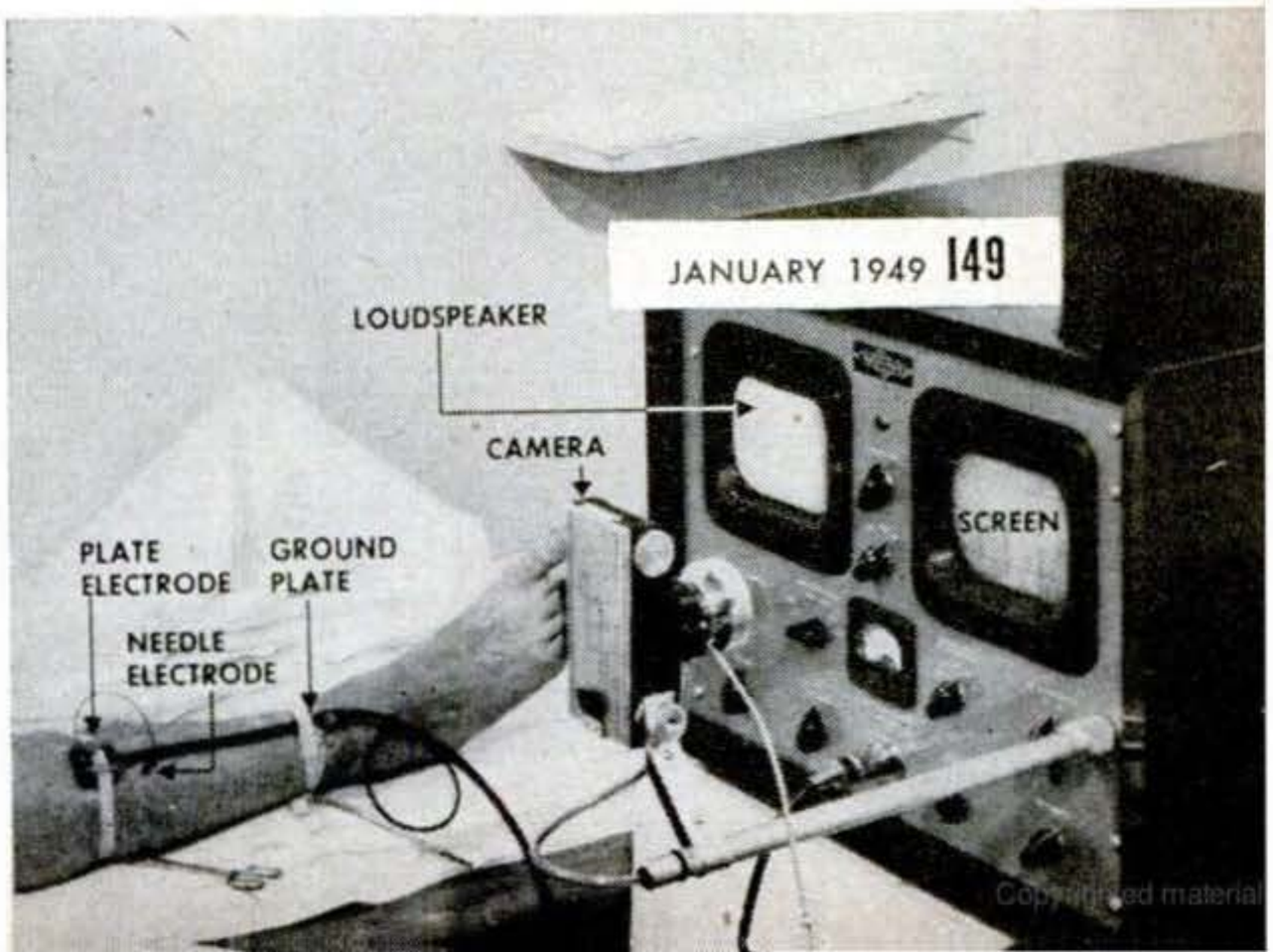


Switch Foresees Dusk

AN automatic switch that fits into the top of an individual street lamp, as shown below, doesn't wait till twilight to turn the lamp on. A photoelectronic eye sensitive to the red rays of the setting sun, as well as to light intensity, snaps the new GE switch just *before* dusk. Dawn's early light, coming in through a slit in the cap, turns the lamp off.

"TV Set" Aids Doctors

THE device below meters activity in nerves damaged by infantile paralysis. The Electromyographᵀ works like a sensitive television receiver. Its needle-like antenna, stuck into the muscle, picks up nerve signals as slight as 1/200,000 of a volt and turns them into sounds from a loudspeaker and lines of light on a viewing screen.



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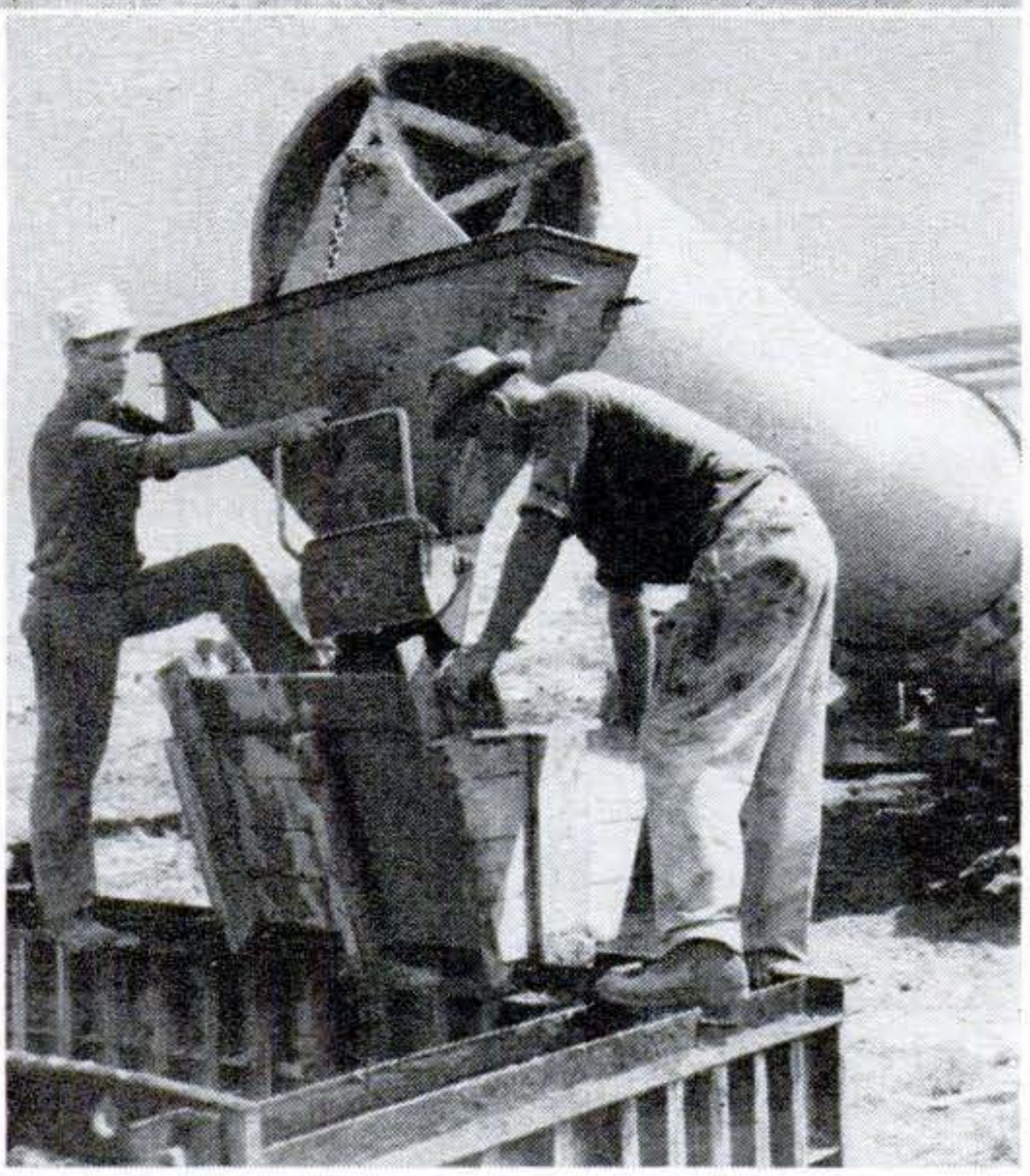
Giant Gun Mixes Cement



THAT'S not the Army's latest howitzer above, but a new type of cement mixer. It is 34 feet long, weighs 16 tons, and mixes seven cubic yards of cement at a time—more than three times as much as ordinary truck mixers can handle. Push-button controls raise the barrel to spew out concrete as high as 20 feet above the ground. A whole house foundation can be poured in a few hours. In use on a large housing development in St. Louis, one unit is reported to turn out in three hours what had been a three-day job. The huge cement guns are mobile, pulled by a big, two-wheel tractor.

There are only four of the giant machines in the whole country. Called Tournamixers®, they are made by R. G. LeTourneau, Inc. Price? $25,000.

Elevator Takes Full Bale

A NEW, versatile elevator is easing farm work. It is 18½ in. wide—enough to take a full bale lying flat—and can be quickly lengthened or shortened with eight-foot extension sections. It operates at any angle from nearly level to about 45°.

Made of double-box sections of 16-gauge steel, it is built on a steel-tube scissors carrier that provides a low center of gravity for safe trailing. It rides on 16-in., auto-type wheels equipped with roller bearings. Howry-Berg Steel and Iron Works makes it.

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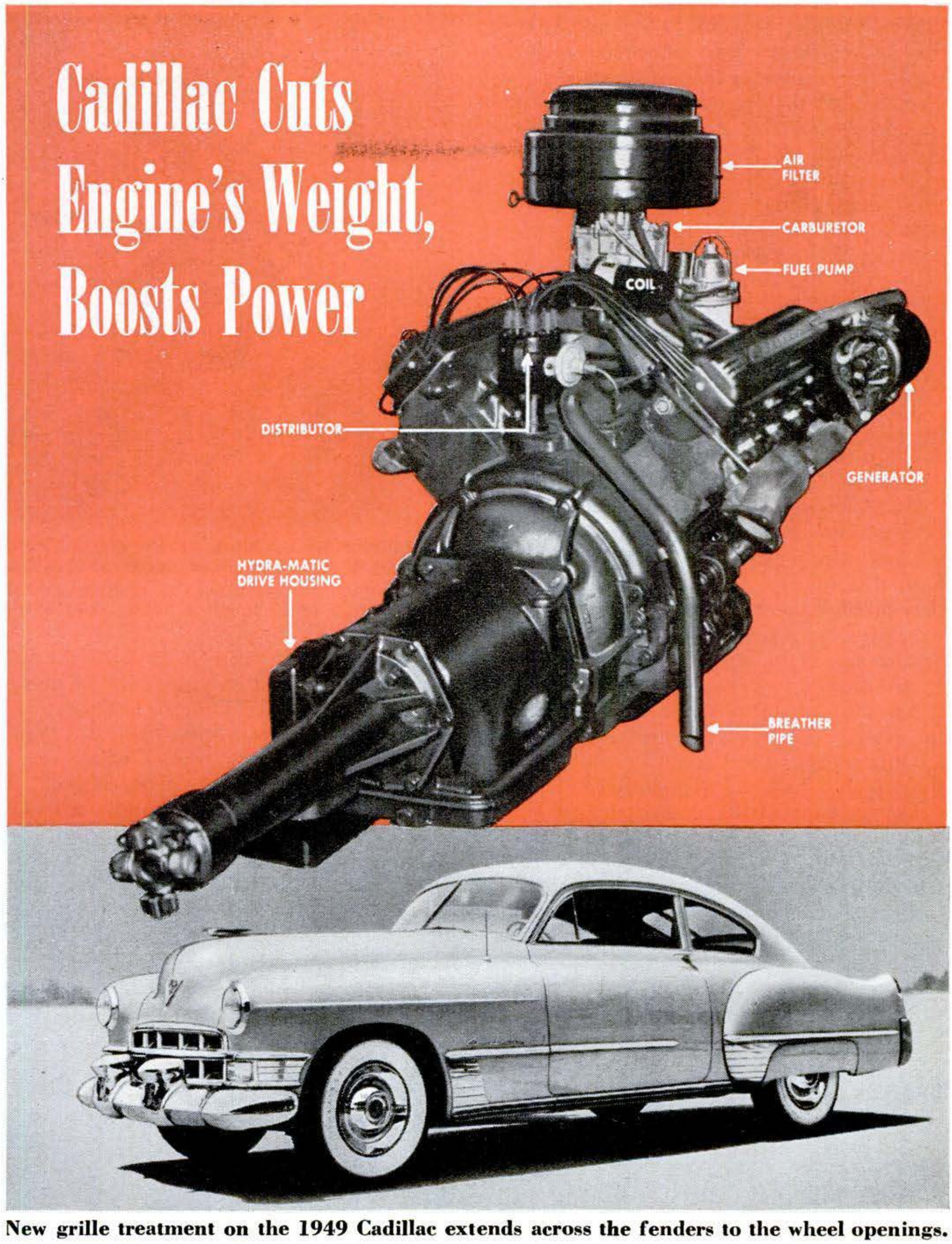
Cadillac Cuts Engine's Weight, Boosts Power



New grille treatment on the 1949 Cadillac extends across the fenders to the wheel openings.

IN HALF a minute, on a straight, level road, the 1949 Cadillac will leap from 0 to 80 m.p.h. The engine that gives it this power has a 7½-to-1 compression ratio—and other new features.

Since 1942, Cadillac has been making a V-8 engine with 7¼-to-1 compression, the level at which Oldsmobile is starting its own high-compression program (see p. 166).

The 7½-to-1 engine, to be used in all Cadillac models for 1949, was developed independently of the Kettering-Olds high-compression work.

Will the fuels now available keep it happy? Upping the compression ratio has always nudged octane requirements a little

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higher. Cadillac engineers obviously believe that fuel prospects warrant stepping up the ratio in *their* engine a quarter of a point now. The changes they've made may reflect their confidence that the existing premium gas is good enough for the new engine.

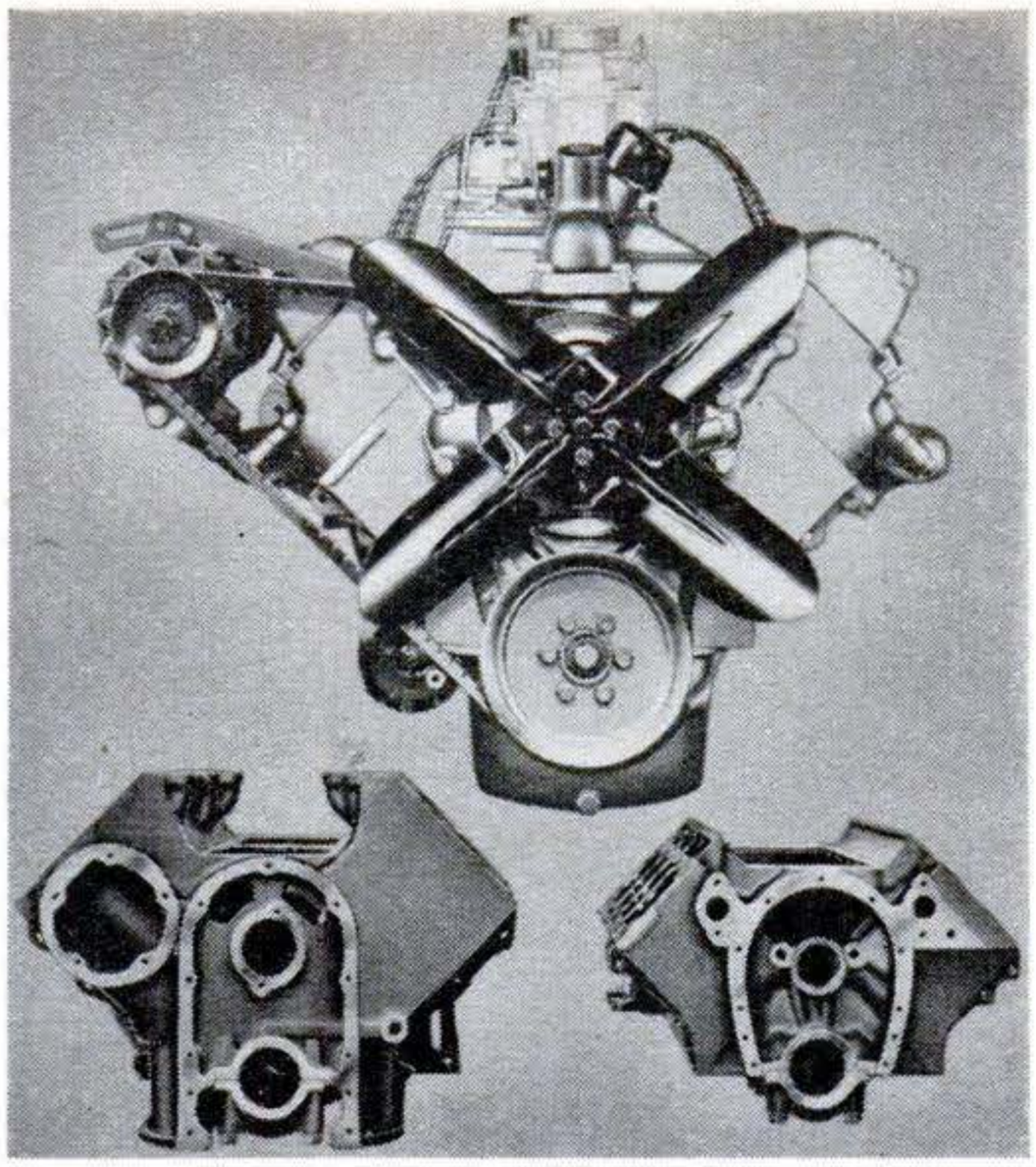
The cylinder bore of the new engine has been made larger and the piston stroke shorter. A new valve-in-head combustion chamber gives greater efficiency. The main crankshaft bearings have been increased from three to five and placed in heavy bulkheads that help form a rigid crankcase structure. Hydraulic valve lifters of new design assure quiet engine operation.

These and other mechanical advances add up to an engine that doesn't *need* a fuel as high in antiknock rating as an older engine that's been similarly stepped up.

Cadillac engineers may also count on the Hydra-Matic Drive (T). Knocking and pinging occur only when an engine is pulling hard. High-octane gasoline is really needed only at such times. If you're driving a manual-shift car, you can get by with a lower octane simply by shifting down before the engine begins to labor—and by not pushing it too hard on starts. When efficiently used, the Hydra-Matic Drive does the same thing automatically. The result: your engine thrives on a fuel of lower antiknock rating.

Compared with its immediate predecessor, the 150-hp. V-8 that powered Cadillac in 1948, the new 160-hp. engine is about 200 lb. lighter and much more compact. It's said to give a 15 to 20 percent increase in fuel economy under most driving conditions.

Because friction and heat losses have been reduced, Cadillac engineers found it possible to use a smaller, lighter radiator. The new cooling system requires only 18 quarts of coolant, compared with 25 last year.



A smaller cylinder block of new design, lower right, accounts for much of the 200-lb. weight reduction in the 1949 Cadillac engine, seen in front view at top. At lower left is 1948 block.

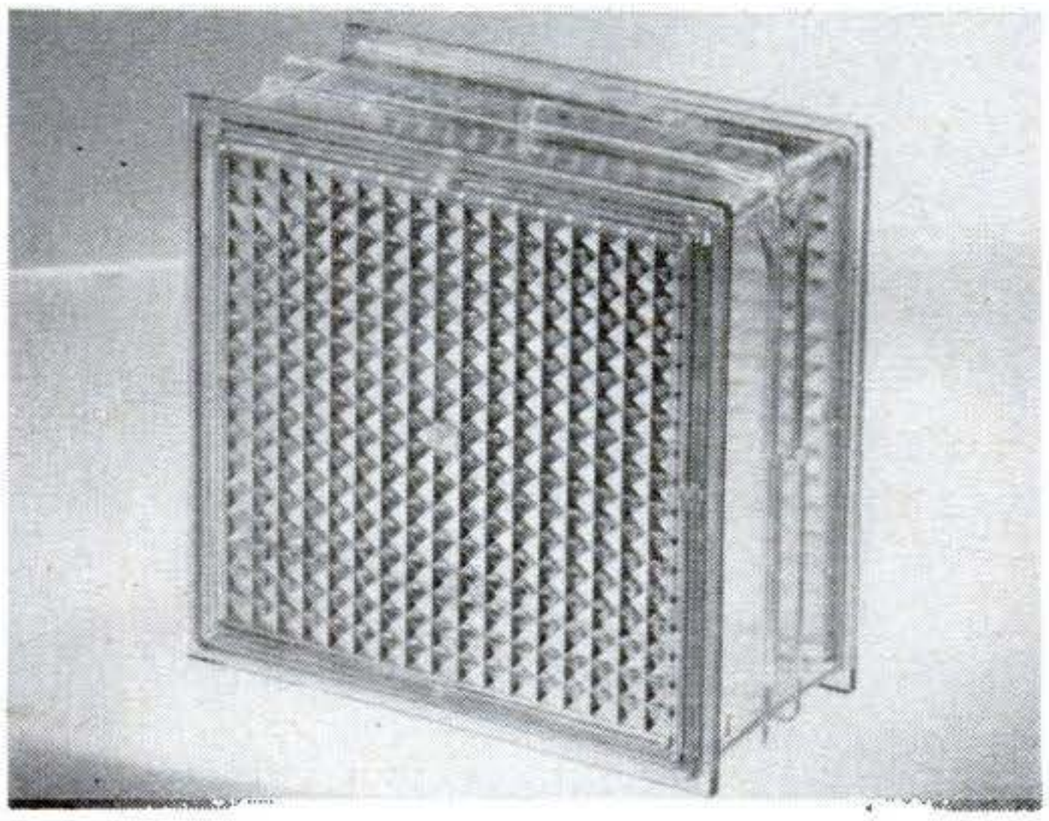
A single casting comprises the water-pump housing and inlet and outlet water manifolds. All hose connections are eliminated except to the lower and upper radiator tanks.

In looking at the engine you'll notice its low over-all height. Contributing to this, besides the flatter block and shorter piston stroke, is a new slipper-type piston that permits a shorter connecting rod. Unused metal at the sides of the piston skirt has also been eliminated. This reduces friction and lessens reciprocating weight. END

Plastic Blocks Interlock to Make Walls

THE plastic block at right, 7¾ in. square and 4 in. thick, weighs only a fifth as much as a glass block of the same size. Designed for building either permanent interior walls or temporary partitions, it is edged with ribs that interlock with those of adjacent blocks to make a wall that will stand up without cementing.

The new blocks have smooth outer faces and interior surfaces of diamond-shaped facets to diffuse light passing through them. The Columbia Protektosite Co., of Carlstadt, N. J., makes them both of clear plastic and in a variety of colors.



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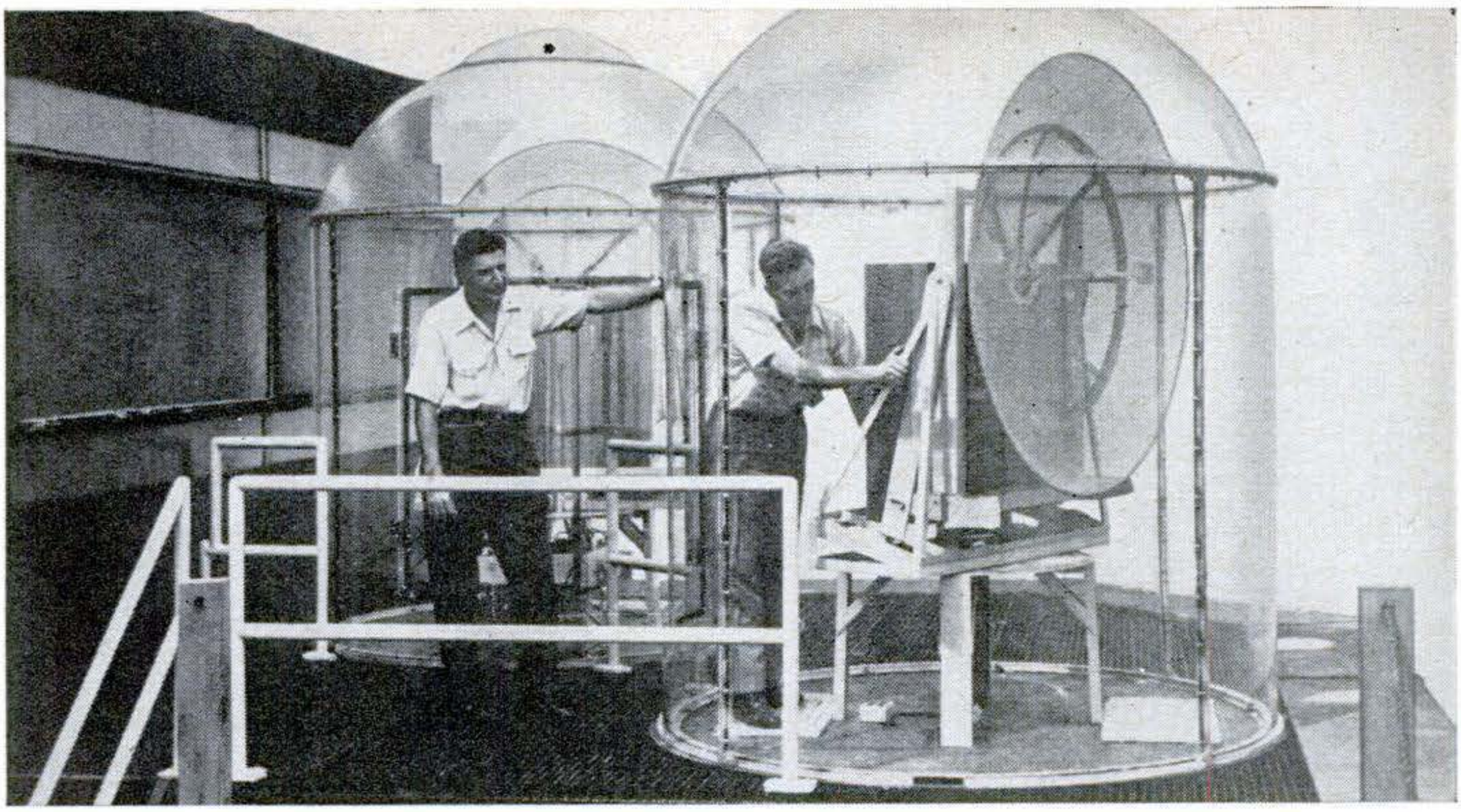
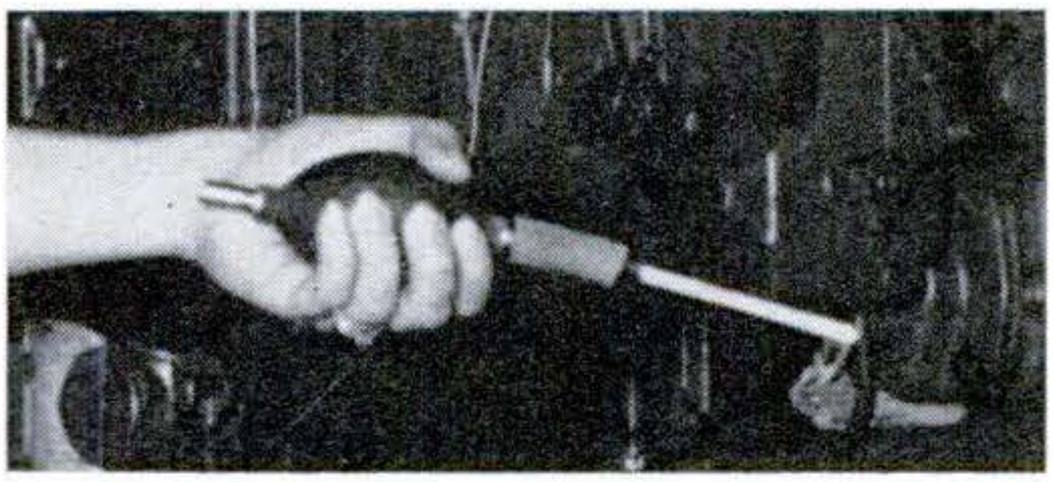


Igloos Keep Wind From Shaking TV Pictures

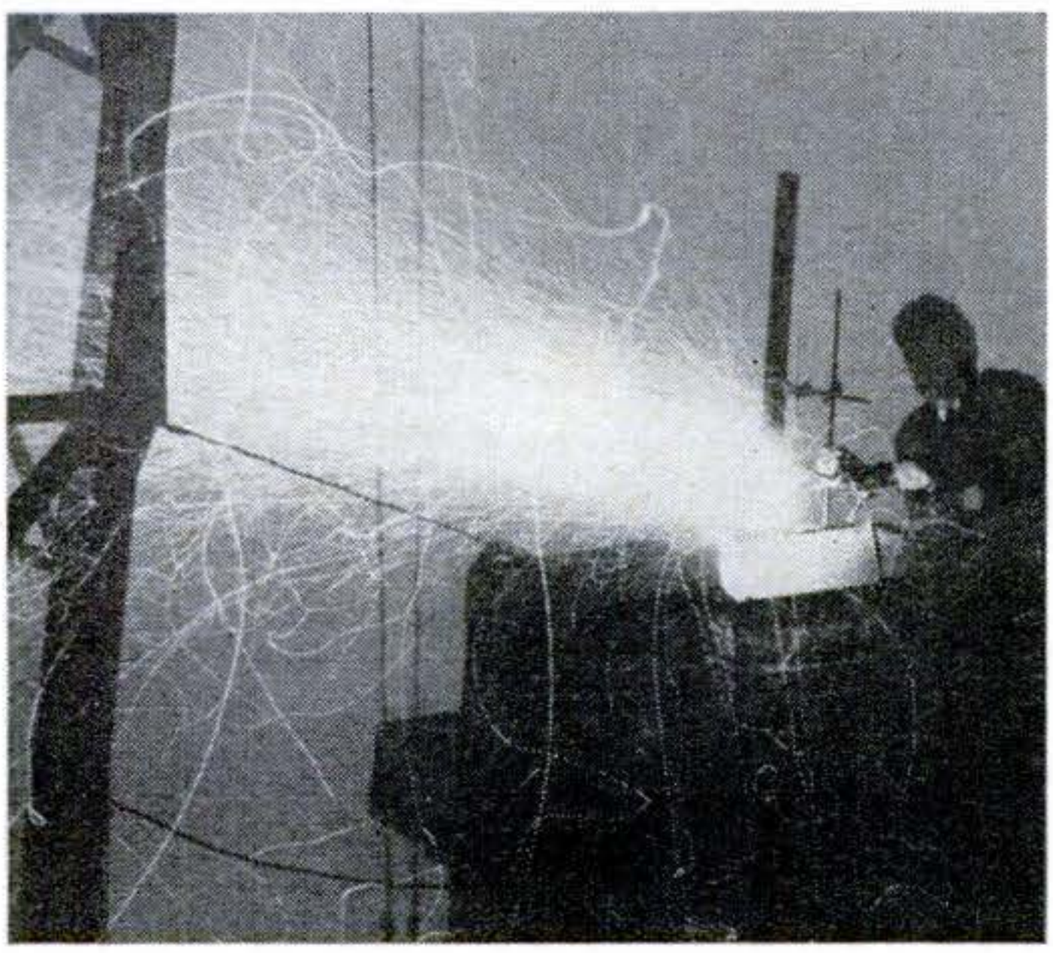
NBC television engineers had a problem: distortion of TV images when high winds shook the short-wave antennas they used to relay programs from mobile cameras to broadcasting stations. This picture shows how they solved it. With the help of N. Y. Telephone Co. engineers, they built igloos of Plexiglas ® right over the antennas outside the 87th floor of the Empire State Building.

The air-conditioned domes, 7 ft. wide and 8½ ft. tall, also shield the antennas from recklessly flying birds and ice that falls from the tower 300 ft. above. Radio waves penetrate their ½-in. walls without noticeable distortion. Doors admit workmen to service the 5-ft.-diameter, saucerlike antennas.



Tube Sniffs Poison Gas

THE pencil-size tube at left, developed by the Bureau of Standards, can detect a trace of carbon monoxide 50,000 times too faint to hurt you. The bulb sucks air through yellow chemicals that are turned green by even 1 part of CO in 500,000,000 of air.



Fire May Cause Rain

THE scientists who built the blowtorch at left hope to use it to start rainstorms. Burning charcoal soaked in silver iodide, it spews sparks that burst into tiny particles on which chilled droplets of water in a cloud will crystallize into snow. The snowflakes, falling into warmer air, may then turn to rain. Tried out so far only in a laboratory, the generator dispenses 100,000,000,000,000 particles a second—enough to seed a cubic mile of atmosphere. General Electric has developed separate models for use in airplanes and on the ground in Army and Navy weather-making experiments.

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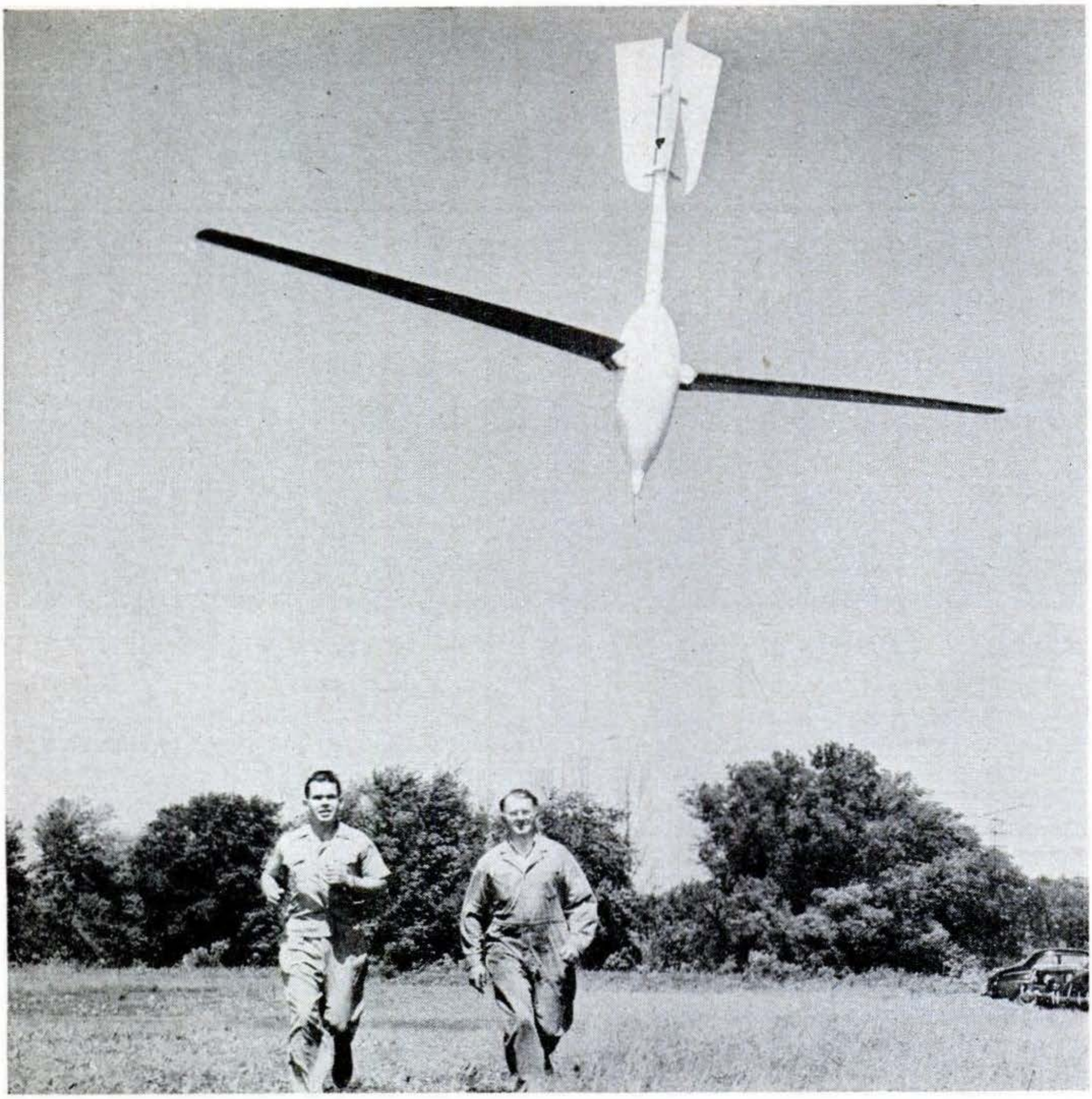

Dart Is Supersonic 'Chute

SPECIAL delivery from a rocket shot 100 miles into upper space is possible with a new "rotochute," shown above about to land. Used to carry delicate research instruments, it resembles a large dart with a propellerlike rotor near its tip.

The device, with a 20- to 30-lb. load, is released from a mother rocket at the peak of its flight into the thin upper atmosphere. Hurtling earthward at supersonic speeds, it goes into operation on entering denser air that would rip an ordinary parachute to shreds. As it revolves, centrifugal force gradually opens the blades of the windmill into a horizontal position. These act as brakes, slowing the device down to a safe landing speed of about 27 miles an hour.

General Electric engineers, who developed the rotochute, designed 23 different experimental models, and subjected some to wind-tunnel speeds of 1,300 m.p.h. To demonstrate the versatility of the rotary-wing air brakes, they not only expelled rotochutes from actual rockets, but dropped them from altitudes as low as 1,000 feet.

The device is expected to supply much valuable information in addition to data on atmospheric conditions that are radioed from the rocket itself in flight. With the rotochute, GE engineers say, chemical samples of the upper atmosphere can be brought to earth for analysis.

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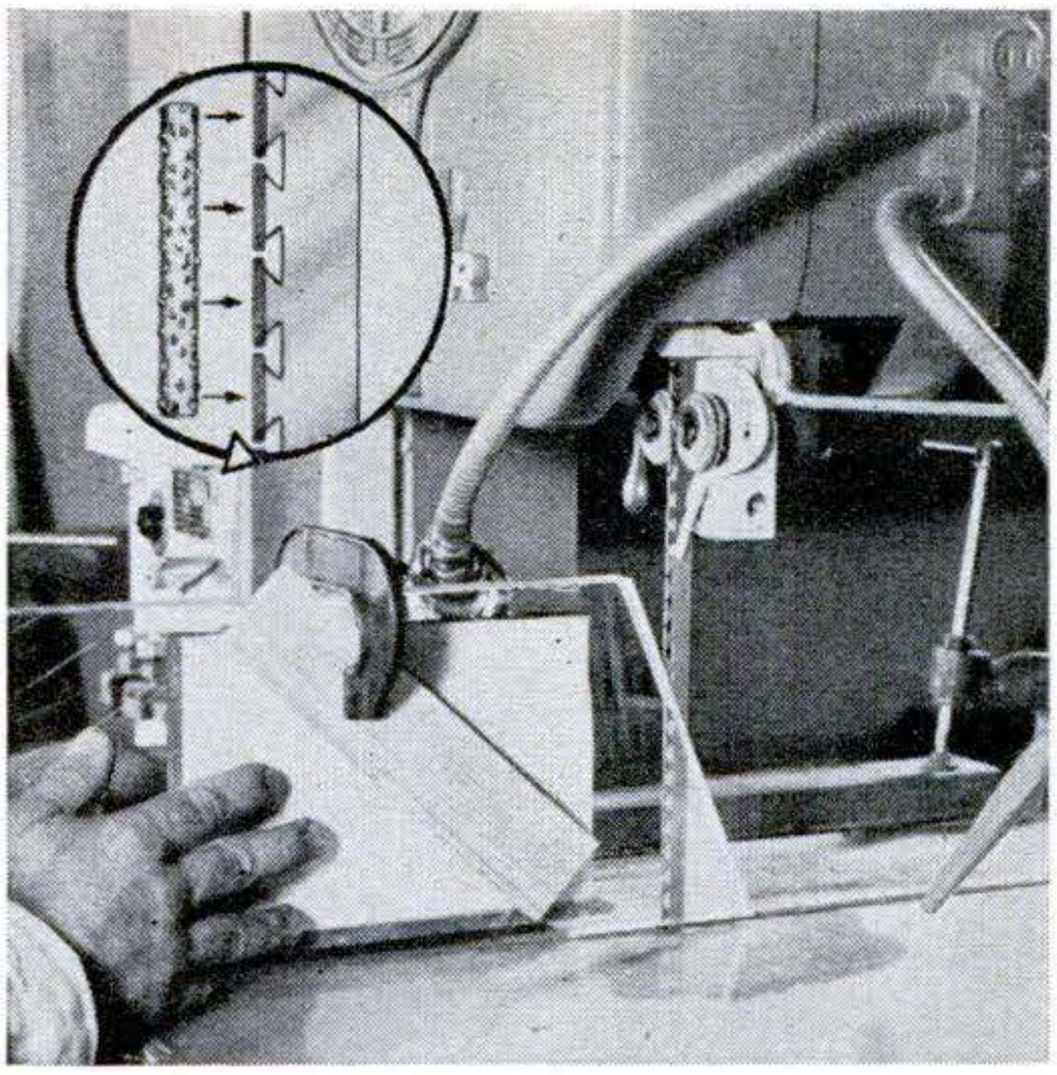
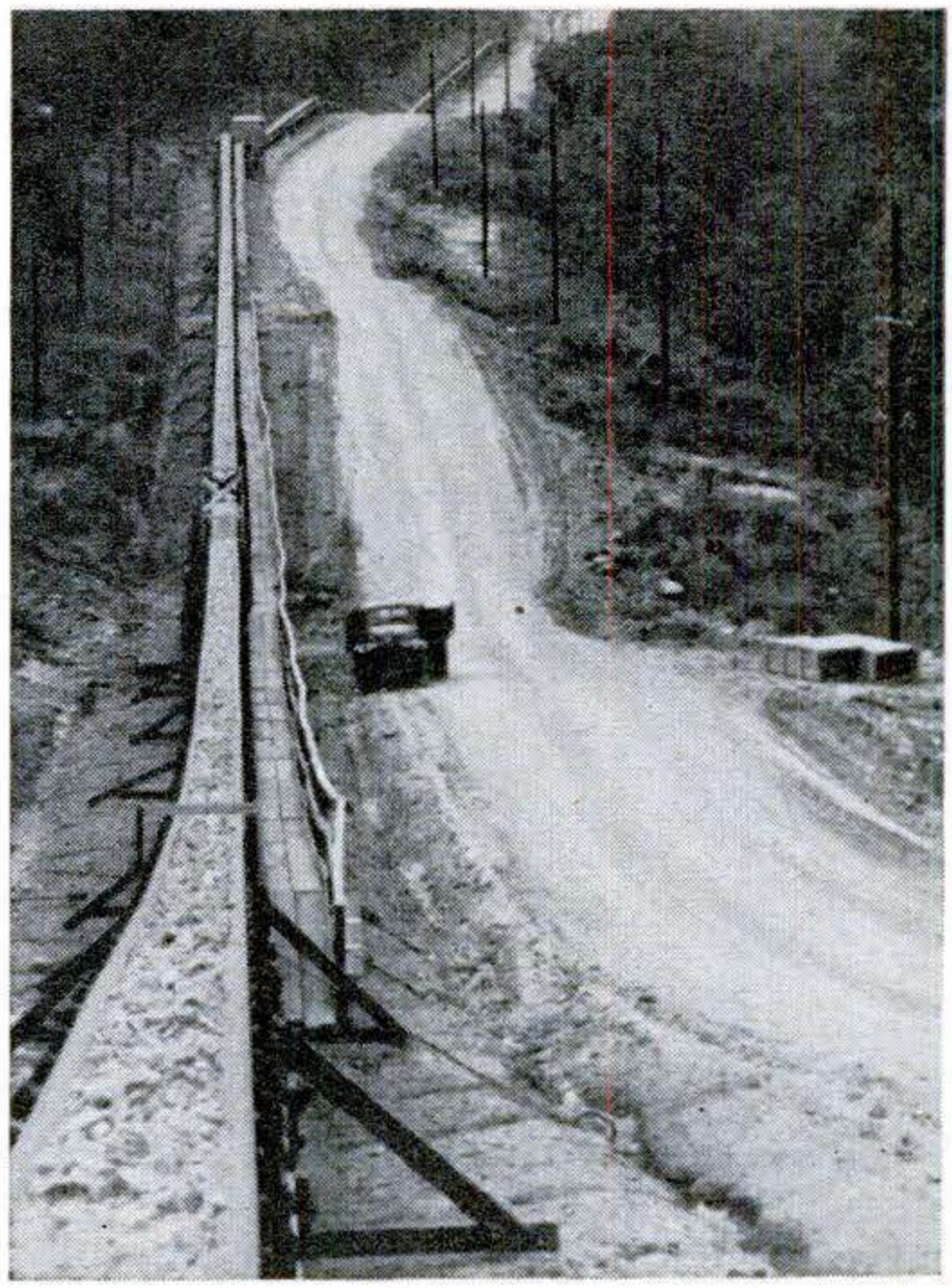


Diamonds Cut Contours

LONG used for cutting extra-hard materials, diamonds are now being bonded to band saws for contour work. Minute diamond particles are embedded in tungsten-alloy matrices, as shown in the inset above, which are then brazed to the teeth of the saw blade. Made by the DoAll Co., the new band saw will contour-cut such hard materials as glass, porcelain, granite, jade, and hardened metals. Heretofore, all such cutting had to be done with disk or mud saws. The saw is shown slicing a slab of glass.

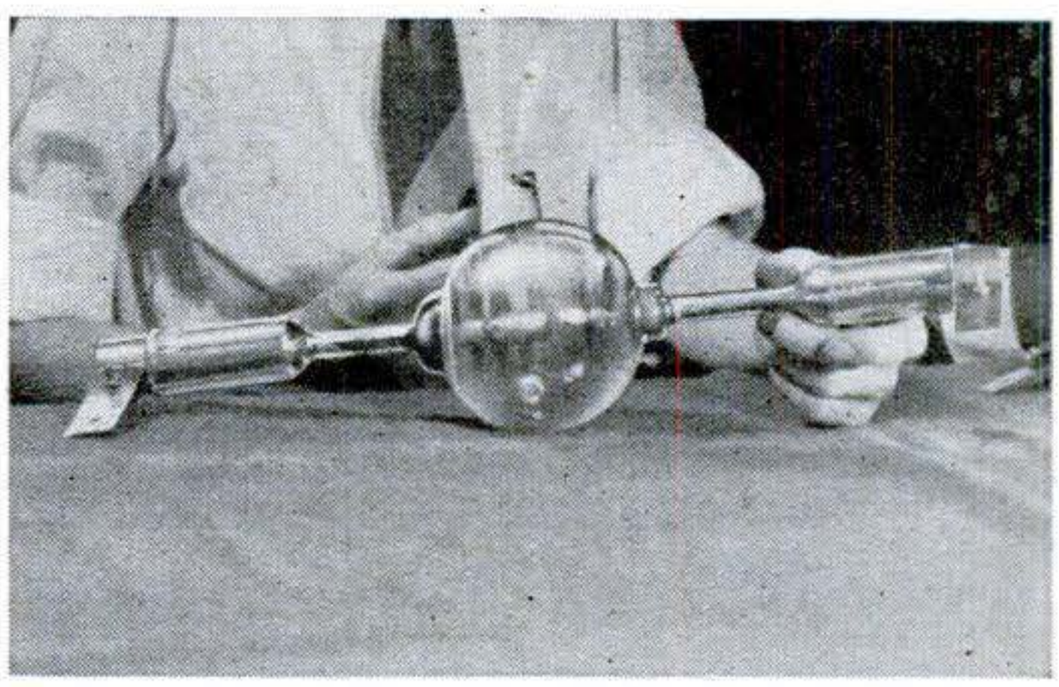


Conveyer Carries Rock

LONGEST of its kind now in use, this overland belt conveyer carries rock seven miles through the rough and wooded Ozark hills to speed the construction of the Bull Shoals Dam at White River, Ark. Crews use the road beside it to keep the belt patrolled.

Machine Erases Records

PLASTIC dictating-machine records, formerly discarded after being used, can now be erased and used again. It takes less than half a minute with this new SoundEraser ®. The electrically operated machine spins a used disk for 29 seconds in a bath of heat from infrared rays. The heat softens the plastic, and the centrifugal force returns the disk to its original smoothness. It will permit a record to be reused as many as 26 times.



More Light for Movies

A PEANUT-SIZED arc in this new experimental 10,000-watt cadmium mercury vapor lamp may soon be shedding more light in motion-picture studios and other places where extreme brilliances are needed. The intensity of the tiny arc, which produces daylight-type light, is nearly half the brightness of the sun. The lamp was developed by Westinghouse and is being made in two types, for direct and alternating current.

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New Way of Printing Adds a Fourth Process To Those Now in Use

Letterpress printing reproduces letters and pictures by inking raised pattern and pressing it against paper.

BETTER calculation

HEROIC COMMANDER
courageous seamen cited

MANY GALLANT OFFICERS
Troop brigade fought furiously

MODERN SOUTHERN MAN
Lovely spring-time in the country

Sample of xeroprinting rolls from laboratory-model press. The machine has a rotary cylinder that prints on a long roll of paper. It clicks off 1,200 feet of work a minute—a speed comparable to that of newspaper presses. The process requires high voltage, but only small amperage.

Copyrighted material

Intaglio, or gravure, pattern is etched into plate. Depressions are filled with ink, which then is absorbed by paper.

Lithography prints from a smooth plate on which a pattern is formed by ink sticking only to greased areas.

Xeroprinting uses electricity to form pattern of powder on plate and then transfer it to paper without pressure.

Static Pops Pictures Onto Paper

By Paul F. Ellis

Born in a kitchen laboratory, xerography makes printing and photography truly electrical.

ONE cool night more than ten years ago two men climbed the creaky stairs to a room above a bar and grill in Astoria, Long Island. The room, once a kitchen, was almost bare.

It had a small sink, a table, and a cabinet. On the table was an array of boxes, trays, and pieces of metal and paper.

One of the men was Chester F. Carlson, a physicist turned patent lawyer. The other was a friend whom he had hired as an assistant in his kitchen laboratory.

"Now," Carlson said, "for the big test."

Some minutes later, he pulled a sheet of paper from a metal plate. On it was printed: "Astoria, October 22, 1938."

Thus was born xerography, the first new technique in 150 years in the art of putting pictures onto paper.

For the next several years Carlson tried vainly to induce manufacturers to invest in his process. Finally, in 1944, his idea clicked with a research firm. Today xerography is about to go on the market.

Xerography uses static electricity to pop pictures and words onto paper.

It is a dry process. And it can be used to print on virtually any kind of surface, as was demonstrated recently by scientists of the Battelle Memorial Institute, of Columbus, O., and the Haloid Company, of Rochester, N. Y., the firm that acquired from Battelle the rights to use and license the process.

Xerography's name comes from the Greek words "xeros," meaning "dry," and "graphos," meaning "writing." It is pronounced ze-rog′-ra-fee.

The new technique requires no soaping, no inking, no pressure, no chemicals. Charges of static electricity do the work, with the help of fine powders.

Key to the xerographic process is a photoconductive plate that corresponds to the film or paper used in ordinary photography. This plate consists of an electrically conductive backing material, such as metal sheet or foil, coated with a photoconductive insulating material. This coating is a nonconductor of electricity in the dark, but becomes conductive when exposed to visible light. One material used for it is anthracene, a coal-tar derivative.

The coated plate is first sprayed with positive electrical charges by passing it beneath a charged wire in a specially designed device. This makes it sensitive to light.

When used for photography, the sensitized plate is then exposed in a camera or in a contact-printing frame in the same way that a silver-emulsion film or silver-emulsion pa-

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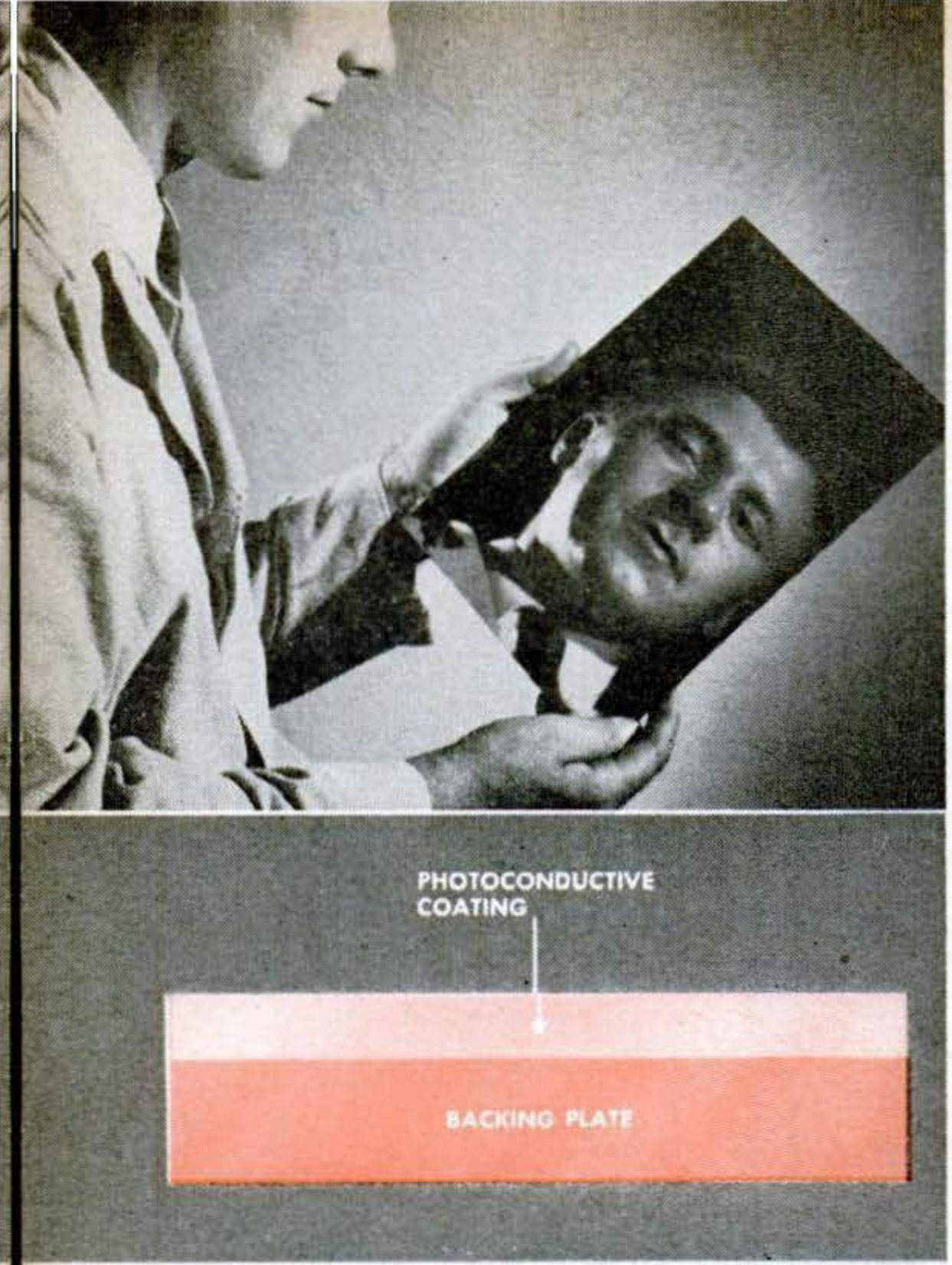
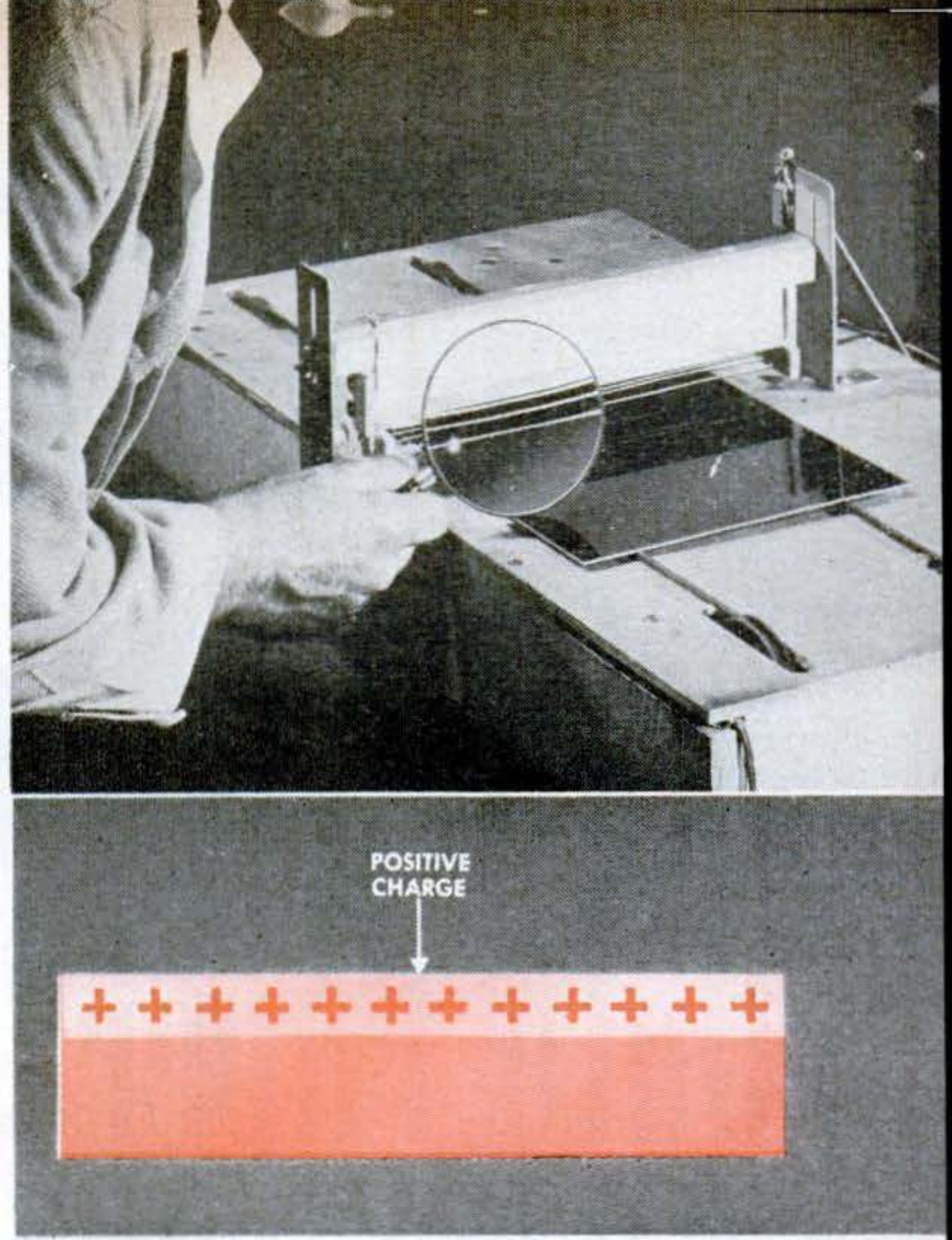
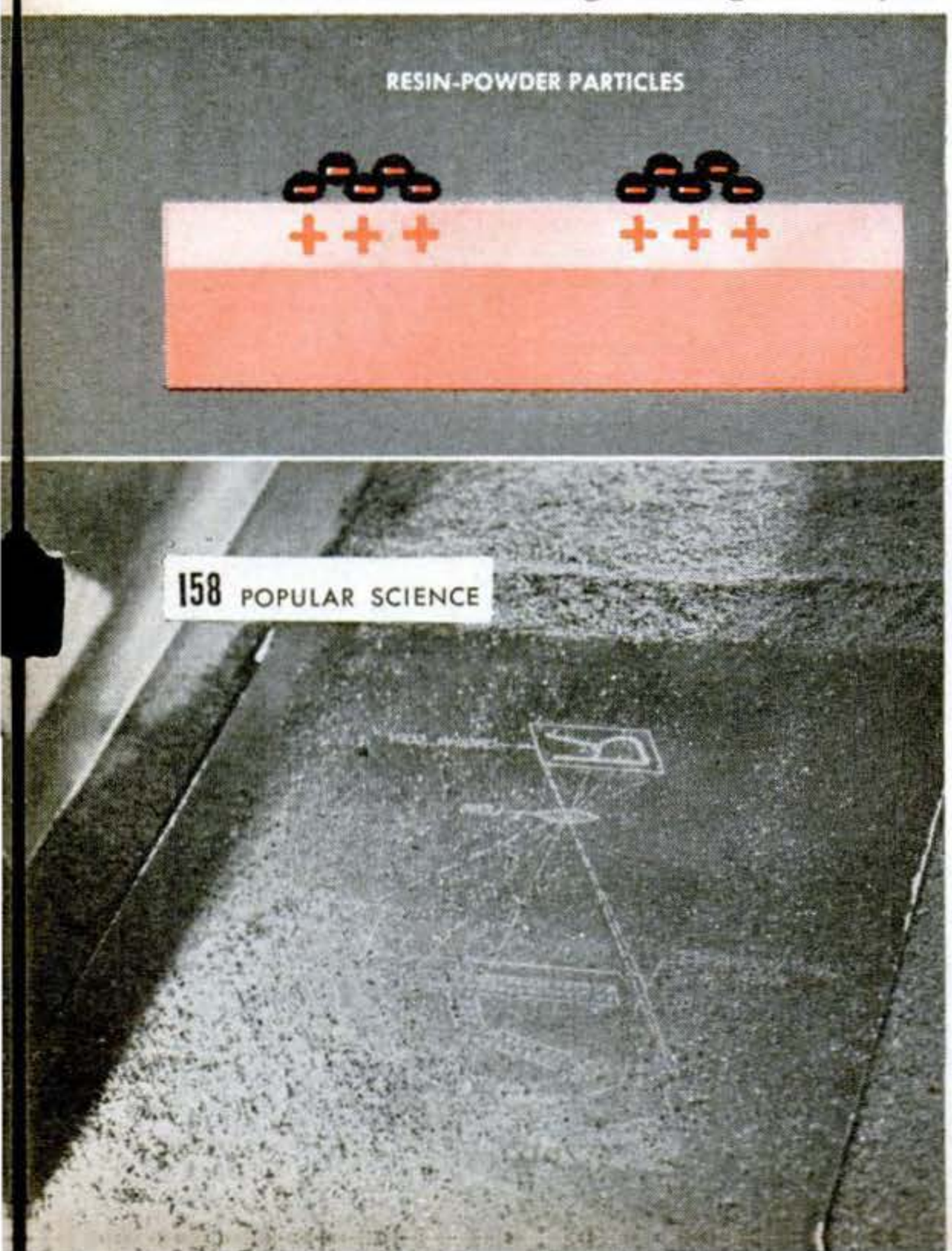


1. Xeroplate consists of electrically conductive backing material coated with photoconducting insulation. Coating is a nonconductor in dark but becomes conductive when exposed to light.

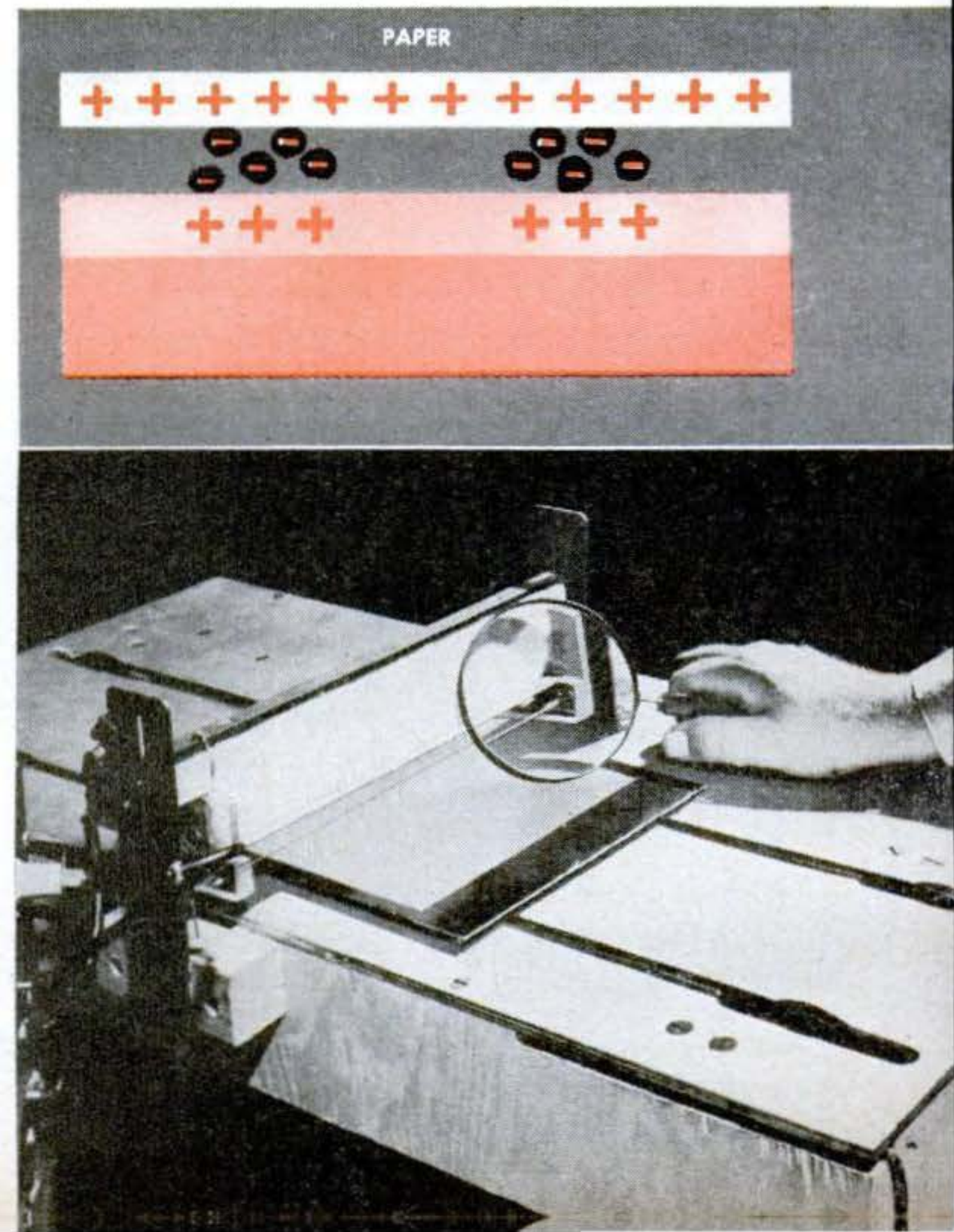


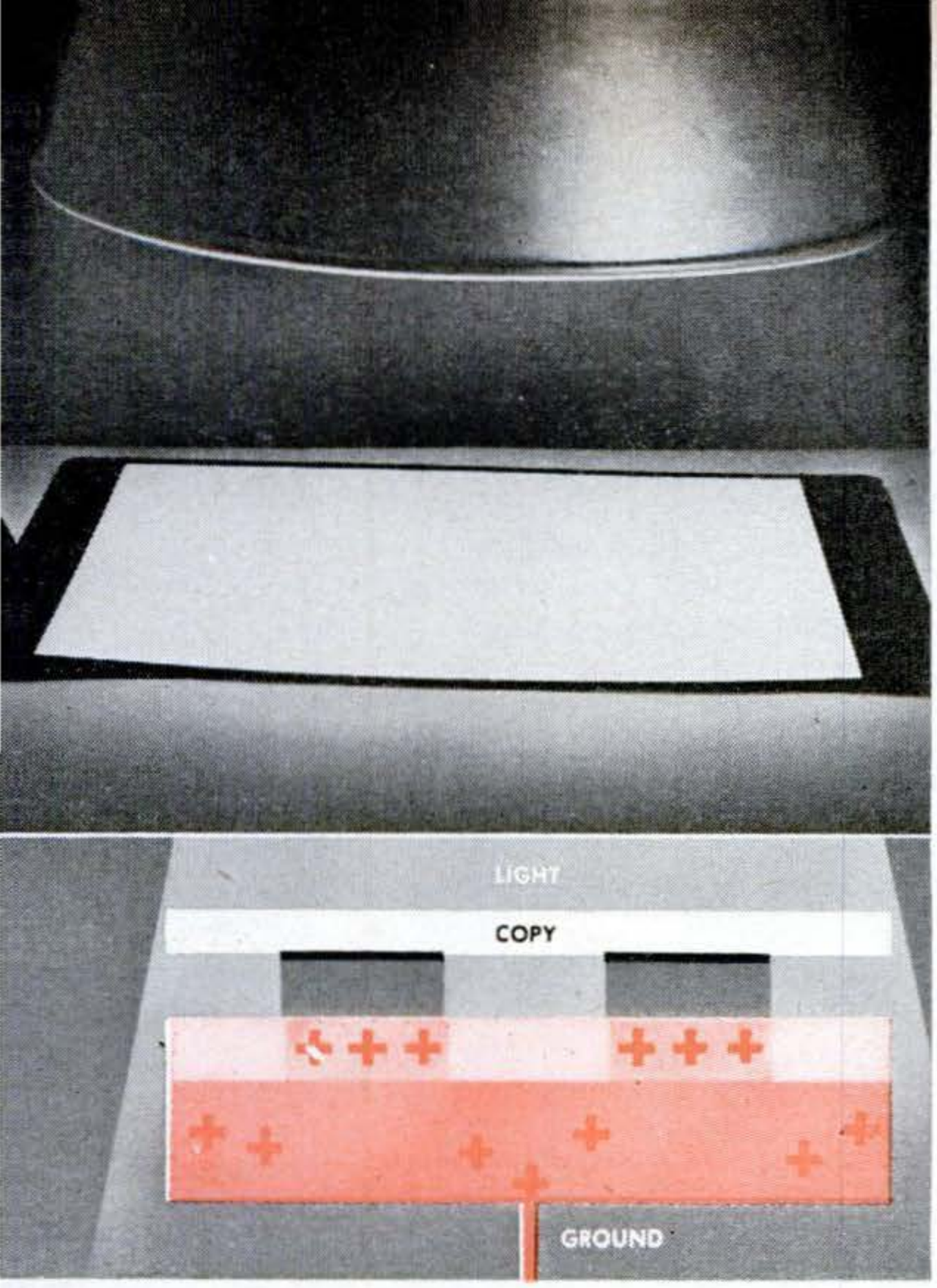
2. Coated plate is sprayed with positive charges by passing it beneath a charged wire (seen through glass). This makes the plate sensitive to light. It is now ready for exposure.

5. Pattern develops on plate as powder collects on areas where exposure to light didn't make surface lose its electrical charge. Grains now form mirror-reversed image of original subject.



6. Sheet of paper is placed over developed plate and both are put under charge-spraying wire. This gives paper a strong positive charge, and powder pattern jumps from plate to paper.

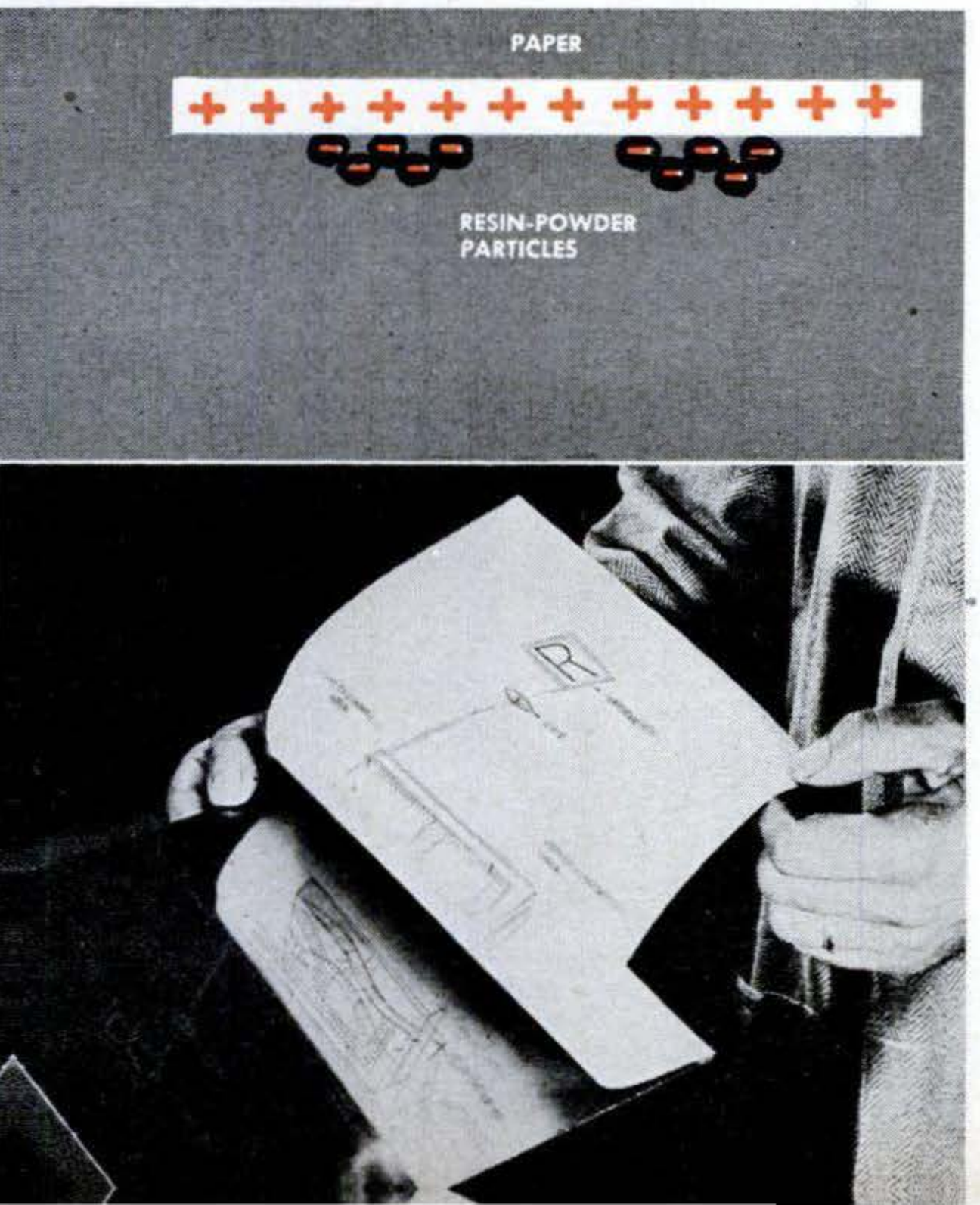




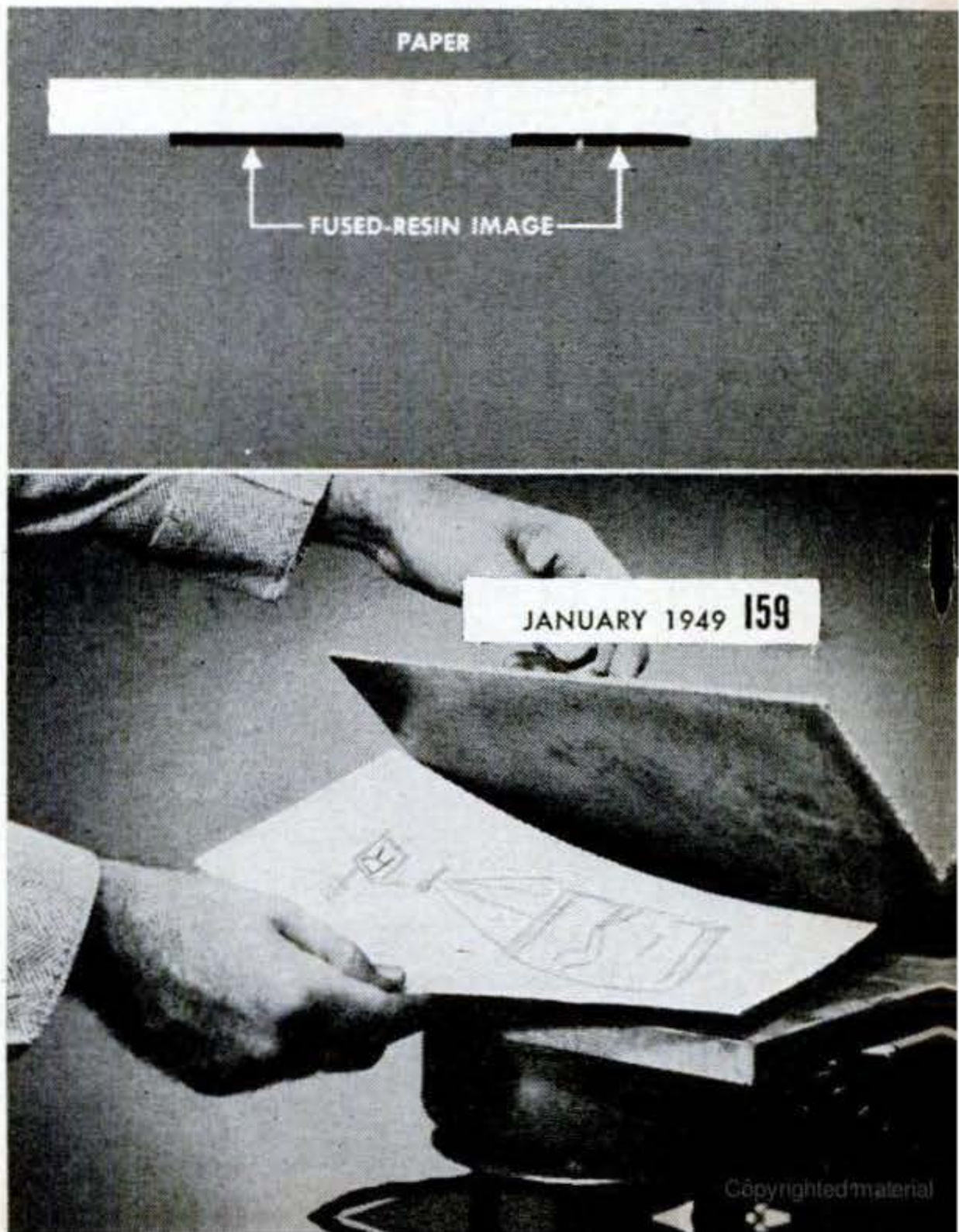
3. Where plate is exposed to light, coating becomes conductive and discharges into plate's backing material. But surface charge remains as latent pattern on places where light doesn't hit.

4. Negatively charged powder is sifted down inclined plate. Grains roll off surface areas that have lost their electrical charge but stop on areas that still retain pattern of positive charges.

7. When paper is pulled from plate, it carries image in true left-right relationship. Since powder is held to paper only by electrostatic attraction, print now may easily be smudged.



8. Image is fixed to paper by placing the sheet between electrically heated plates for a few seconds. Heat melts grains of resin and fuses them to paper as permanent, nonsmearing print.



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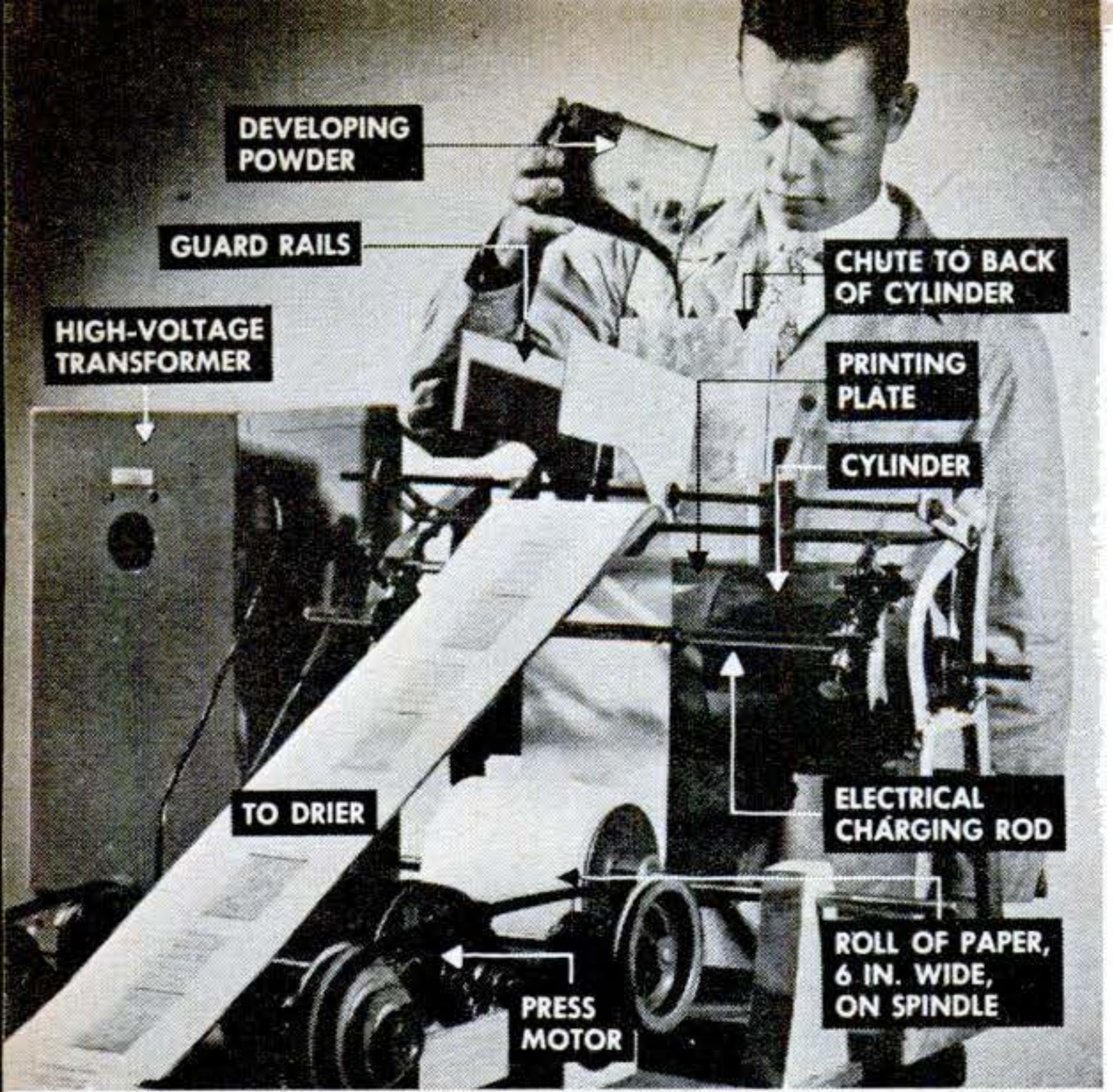

In xeroprinting press, strip of paper picks powder images off plate on cylinder and then runs through heat chamber for fixing. Operator is pouring powder "ink" into chute to xeroplate.

per is exposed to an image pattern. Wherever light strikes the plate the coating becomes conductive and discharges its electrostatic surface charge into the backing metal. On the places where light does not fall, the surface charge remains.

Development then makes that latent, electrical image visible to the eye. This is done by flowing specially prepared developing powder over the plate. The powder is made of two components: a relative coarse carrier material and a superfine developing resin—powdered asphaltum or synthetic resins having low melting points.

And here, again, electricity goes to work. The powder, negatively charged, is attracted to the positively charged portions of the plate and sticks to them. But it rolls off the light-affected portions, since they haven't any electrostatic charge to hold it. The result is a mirror-reversed positive image, in powder, of the original subject.

With the image on the plate, the next step is to make a permanent print from it. This is done by laying a sheet of paper over the powdered plate and charging the paper with the same charge-spraying device that was used to sensitize the plate. The powder particles thereupon lose their affinity for the plate and are attracted, instead, to the charged paper. They literally are pulled through space by the electrical charges.

This transfer restores the image to its true left-right relationship.

Next comes the fixing—making the print permanent. The freshly developed print is simply exposed to heat for a couple of seconds. Heating melts the grains of powder and fuses them to the paper to produce a permanent, nonsmearing print.

From xerography comes xeroprinting—even simpler, and a technique that some day may be used to print newspapers. The Battelle and Haloid engineers already have built a model press that prints with the speed of an ordinary newspaper press.

Xeroprinting, too, is done from a plate that consists of an image of electrically insulating material on an electrically conductive backing, such as a metal sheet. The plate may be made by conventional photochemical processes or by xerography. It is also probable, the Haloid engineers believe, that a plate could even be prepared on a typewriter by using a special carbon paper to provide the electrically insulating image material.

How the Press Works

The xeroplate is fastened to the cylinder of a special rotary printing press. In this, the image plate first passes under a device that spreads an electrostatic charge evenly over its entire surface. The charge immediately passes off the conductive—nonprinting—areas but remains on the insulating—printing—areas.

As the cylinder turns, the plate then enters a developing chamber. Here powder is cascaded against it but sticks only to the parts of the plate that still carry the electrostatic charge.

At the next position of the cylinder the developed plate passes under paper fed into the machine the same way as in ordinary printing presses. The paper and plate next pass under discharge points that simultaneously transfer the image to the paper and recharge the plate for the next revolution. The paper, bearing its powder image, then passes through a heating unit. And there, just as in xerographic photoprinting, the image is fixed by fusing the powder to the paper. END

Traffic Resistance

Do you step on the brakes fast enough? If you don't, maybe you can blame it on your diet. Drs. W. W. Tuttle, Marjorie Wilson, and Kate Daum, of the University of Iowa, report that short rations of the B vitamin called thiamin slowed the reaction time of a group of both men and women in tests.

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Firemen Learn How to Smash Glass Safely

WHEN Chicago's stores and shops began to blossom out with doors, walls, and display windows made entirely of tempered glass, local firefighters began to worry. Just how did you get into a burning building through glass five times stronger than ordinary glass? What would it take to break it? What would happen when it did break?

To find out, they cooperated with the Pittsburgh Plate Glass Co., which supplied Herculite ®, to put this tempered glass through grueling tests. Conclusions: Though harder to break than ordinary glass, it is safer, since it simply crumbles into small, blunt, harmless fragments. But don't try to butt your way through it—four huskies with a heavy ladder couldn't even scratch it. An ax or other sharp, hardened-steel tools will do the trick, but watch your eyes!

Ordinary glass breaks easily, shattering into sharp, jagged splinters. But now notice pile of blunt, rock-candylike lumps on the ground. These are fragments of broken tempered glass.

Running lunge by two men with steel-tipped pike pole fails to pierce ¾-inch door panel of tempered glass—note how pole bends. Later, four men ramming with 26-foot ladder also failed.

Heavy blow from sharp pick of fire ax finally pierces tempered glass but makes only small hole. Rest of pane cracks into lace, does not fall, but can be pushed out easily with ax head.

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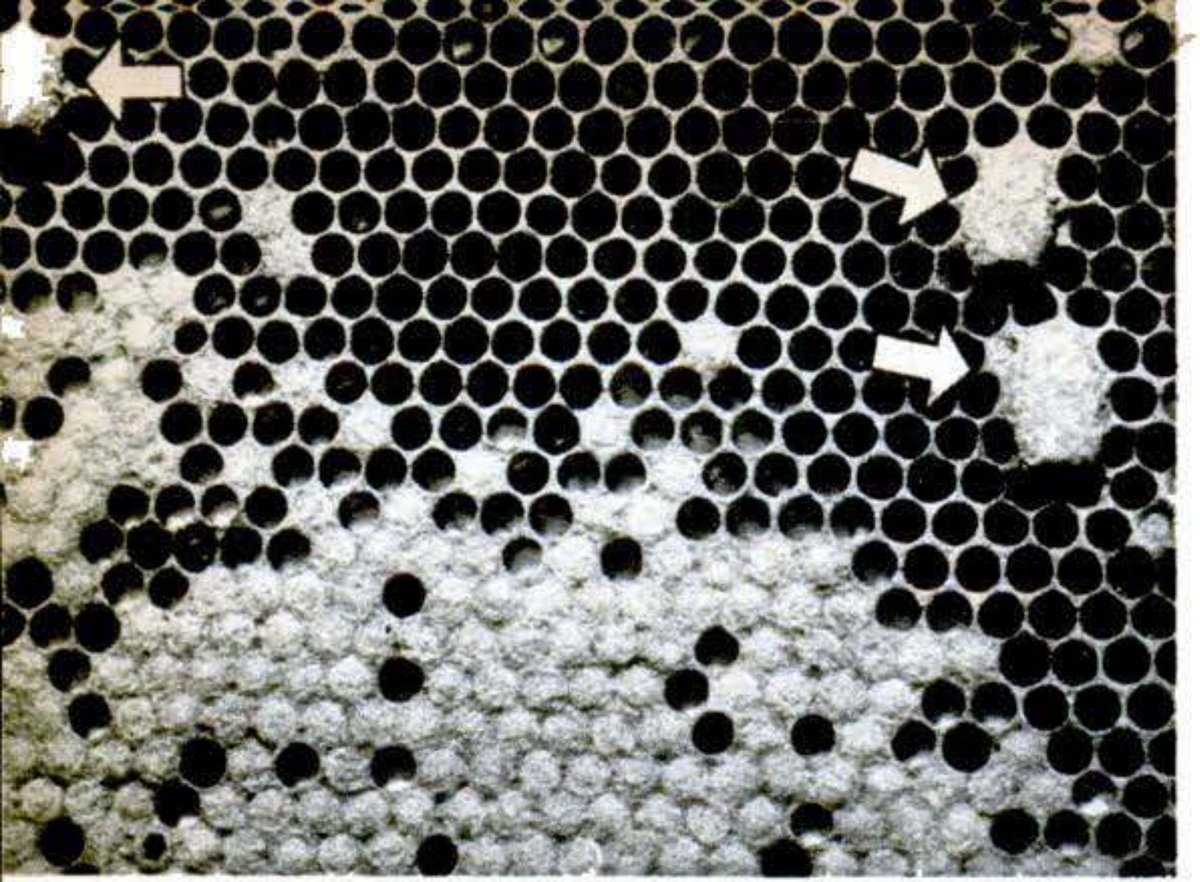
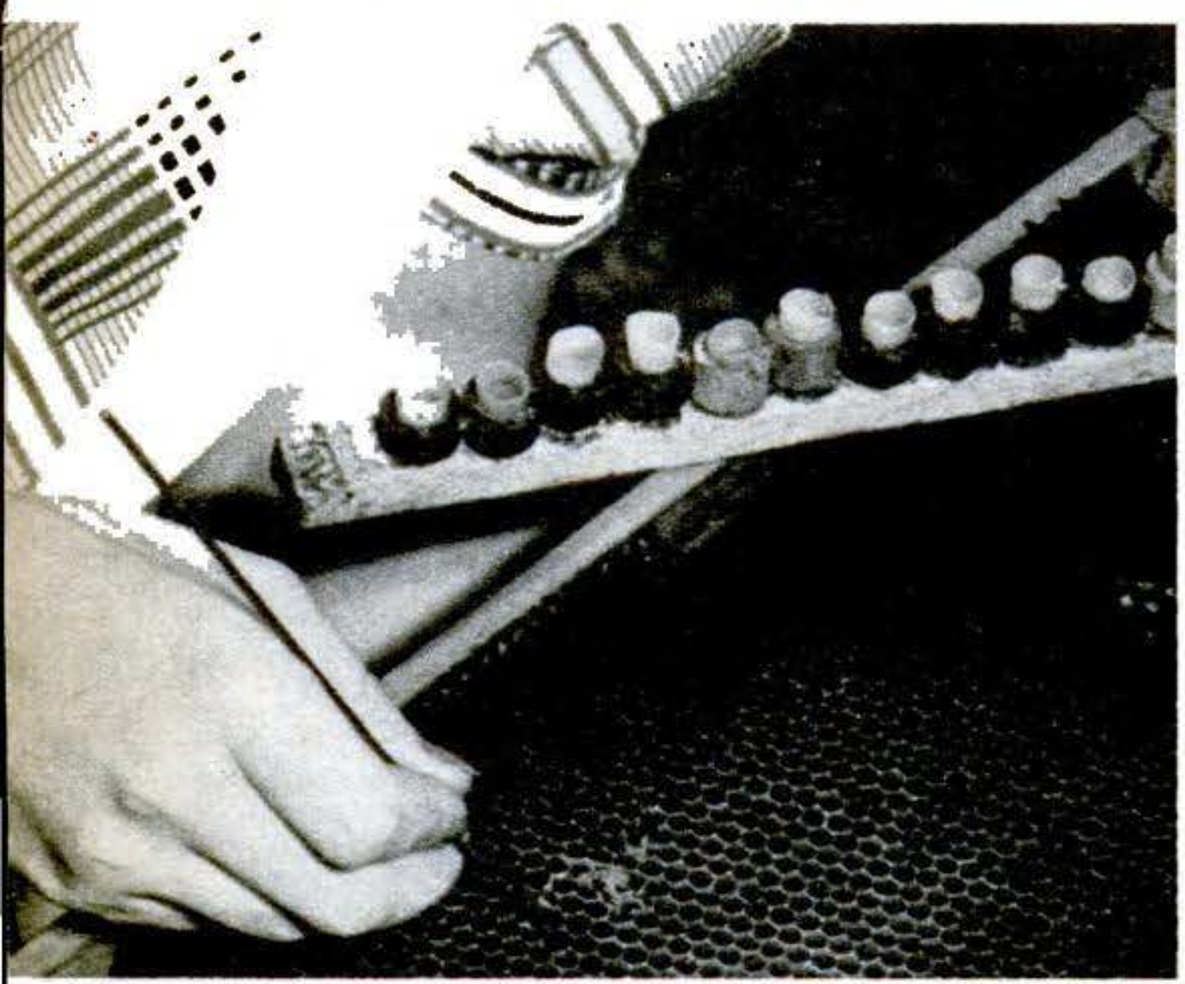
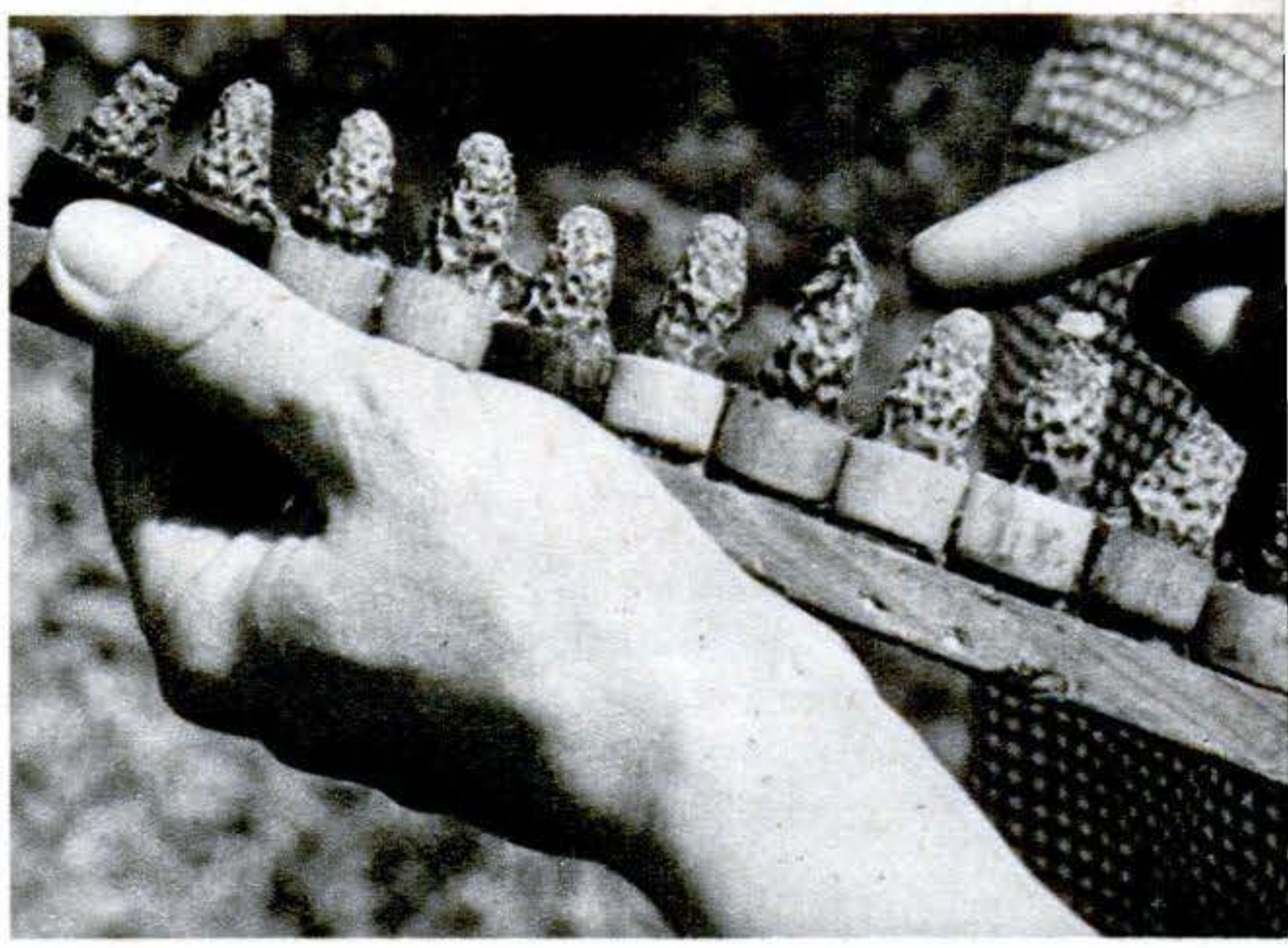


Nature's way: When queen bee dies, workers in her hive raise new one by feeding secretion of "royal jelly" to ordinary female grubs in enlarged cells (arrows). First to hatch kills the others.

Speed-up: Small amounts of highly nutritious royal jelly, taken from partly developed queen cells in hives, are transferred to artificial starter cells by attendant with spatula-tipped instrument.



Female grubs are lifted carefully from their natural cells and planted in artificial queen cells stocked with royal diet. Without this special food, the grubs would grow into worker bees.



After incubation, young queens are removed from cells as they hatch. Here, bee-farm attendant points to one just emerging. The queen will now be moved to a small hive of her own.

Queens for Sale

By Ross E. Hutchins

YOU know about—probably have seen—pure-bred cattle, thoroughbred horses. But did you know there are thoroughbred queen bees, too? Raising them, in fact, is big business.

The bee farm where these pictures were taken has 200 apiaries scattered over six counties in Mississippi and five in Georgia. Last year it shipped more than 60,000 thoroughbred queens and 240,000,000 workers by rail and air to practically every U. S. state and several foreign countries. Its sales, with queens at 75 cents to $1.40 apiece and workers at $1.50 a pound (4,000 bees), ran close to $200,000.

This buzzing enterprise, the Stover Apiaries, with headquarters at Mayhew, Miss., is strictly a stock farm: it sells no honey. Instead, the hives are managed so that all the honey the bees collect is converted into more bees. Since bees are not truly domesticated—can't be bred at will like cattle and horses—this calls for tricky handling while they're doing what comes naturally.

Neatest of these tricks is the mass production of queens by artificially feeding young workers a special royal diet. As a result, hundreds of queens—instead of only one—can be raised for market from a single hive. These photos show how.

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In her own hive, queen (center) is attended by circle of workers—infertile females—who feed and clean her. From here she makes her nuptial flight, mating high in the air with a drone—who then dies. Queen returns to begin her life work of laying eggs and is now ready for market. Queen mates only once but may live several years and lay as many as 2,000 eggs a day.

Mated queen is removed from hive and placed in small wooden cage for shipment. With each queen go half a dozen workers to feed her on the trip and a bit of sugar candy for food.

Cages of queens and attendants are bundled at Mayhew, Miss., and addressed to Poland, France, the West Indies. Bee farm also ships larger boxes of 8,000 to 20,000 workers and one queen.

Separate lounge section equipped with leather-upholstered chairs and sofa is provided in new luxurious coach lounges built by Budd Co. for Chesapeake and Ohio. It seats eight persons.

Passengers on the coach lounges can check their luggage in private lockers found in each car. The key can be removed only when baggage is put inside the locker. Open racks are also provided.

Travel Coach—in Luxury

COMFORTS unknown even to first-class passengers go with the price of a coach ticket on the Chesapeake and Ohio's new super de luxe trains. They are equipped with the Budd Co.'s coach lounges, each having a separate lounge section, big photomurals, curving aisles, a private locker for your baggage, growing plants around the entrance, a clock, a writing desk, and a lending library.

The coach lounge cars are made entirely of stainless steel, and are unusually spacious, seating only 36 passengers. Seats are the reclining, Sleepy Hollow ® type, while the lounge section has club chairs and a sofa.

Traveling children get special attention in Budd's family coach. It has a small movie theater and a plastic-enclosed play yard—equipped with toys and books—to keep youngsters amused on long trips. For the babies there are portable bassinets, a small kitchen with refrigerator, hot plate, and sink for preparing formulas, and even a special room for changing diapers. A hostess is on hand to help harassed mothers.

Babies are treated like Very Important Persons in the family coach. Bassinet clamps in place at each seat so that small children can eat and sleep comfortably during a long train trip.

What looks like the maze psychologists use in tests with rats (below) is really an unusual arrangement of two-place seats so that everyone can watch the scenery from observation car.

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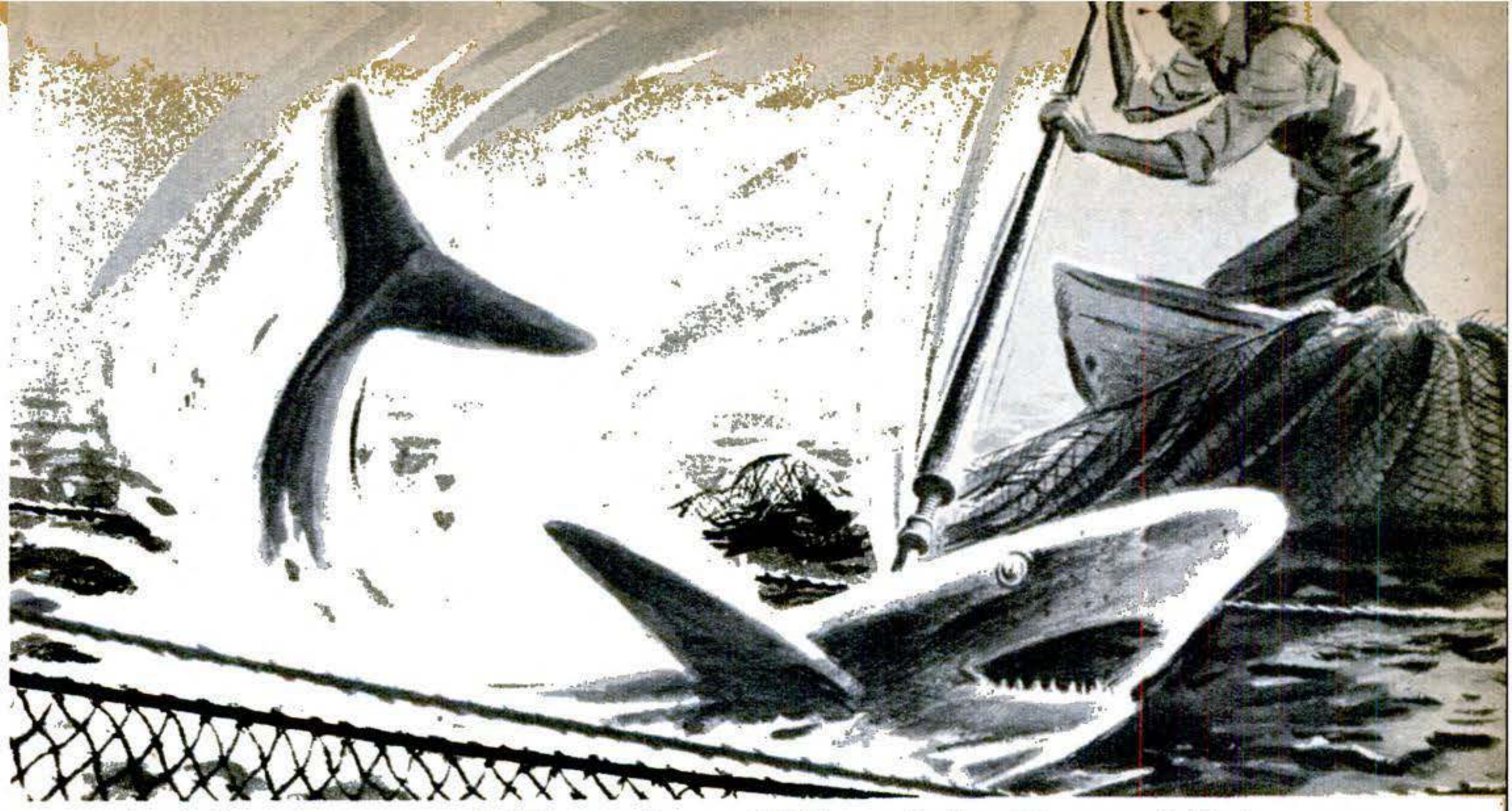


Angry shark, brought up in trap laid for smaller fish, is shot before it can rip the net. Gun on end of 10-foot pole fires 12-gauge shell at zero range when fisherman jabs it against the target.

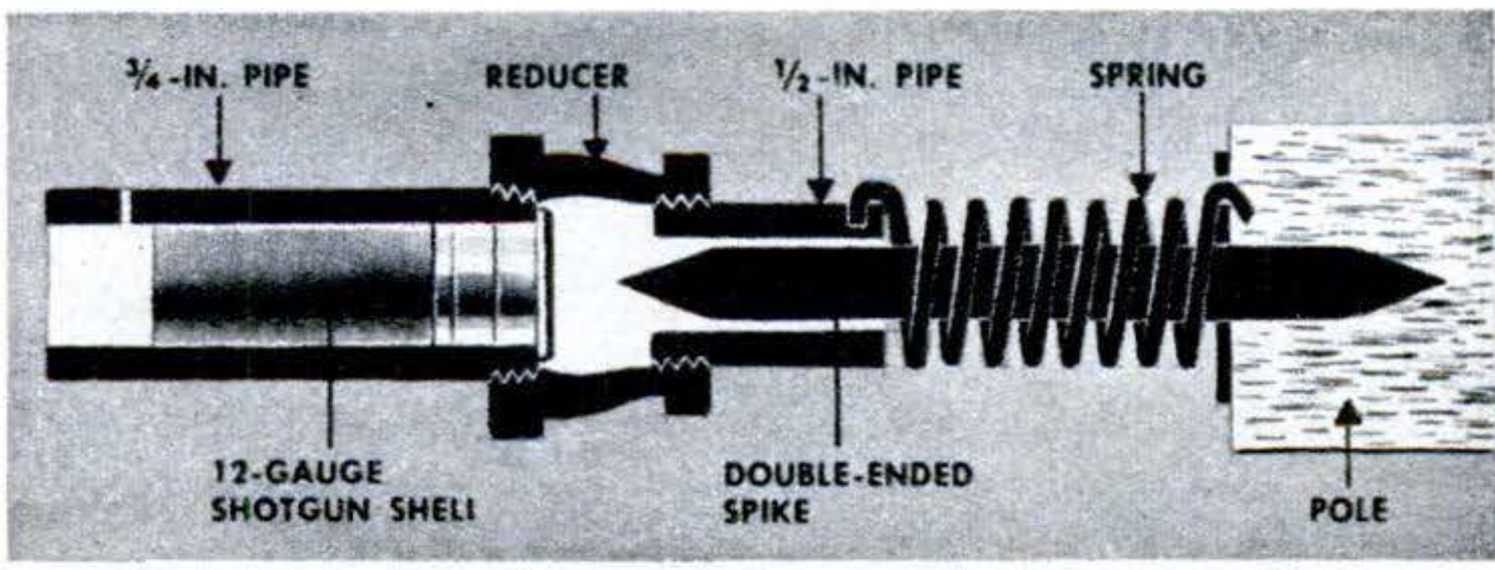
Homemade Shark Gun Can't Miss

YOU won't find this gun in any sporting-goods store or marine outfitter's catalogue. Yet it is fast becoming standard equipment for Cape Cod trap fishermen.

Purpose: to kill a trapped shark before it can rip up nets worth thousands of dollars and free a catch of marketable fish.

Homemade from readily available materials, the weapon kills more quickly than a harpoon—and is surer than a regular shotgun. Because it fires only on direct contact with the target, it can't miss.

Dead shark, killed with second jab of gun, is hauled into skiff by Captain Harry Handy, of Woods Hole, Mass. Boat is inside circular trap of nets anchored to poles in shallow water.



Cutaway view shows how simply shark shotgun is made. Pipe reducer coupling holds shell in barrel, and spring hooked into pole and smaller pipe keeps gun from falling apart. To load it, as shown at right above, unscrew the larger pipe, slip shell in, and reassemble. When muzzle touches shark, push on pole fires shell by driving point of spike against its percussion cap.

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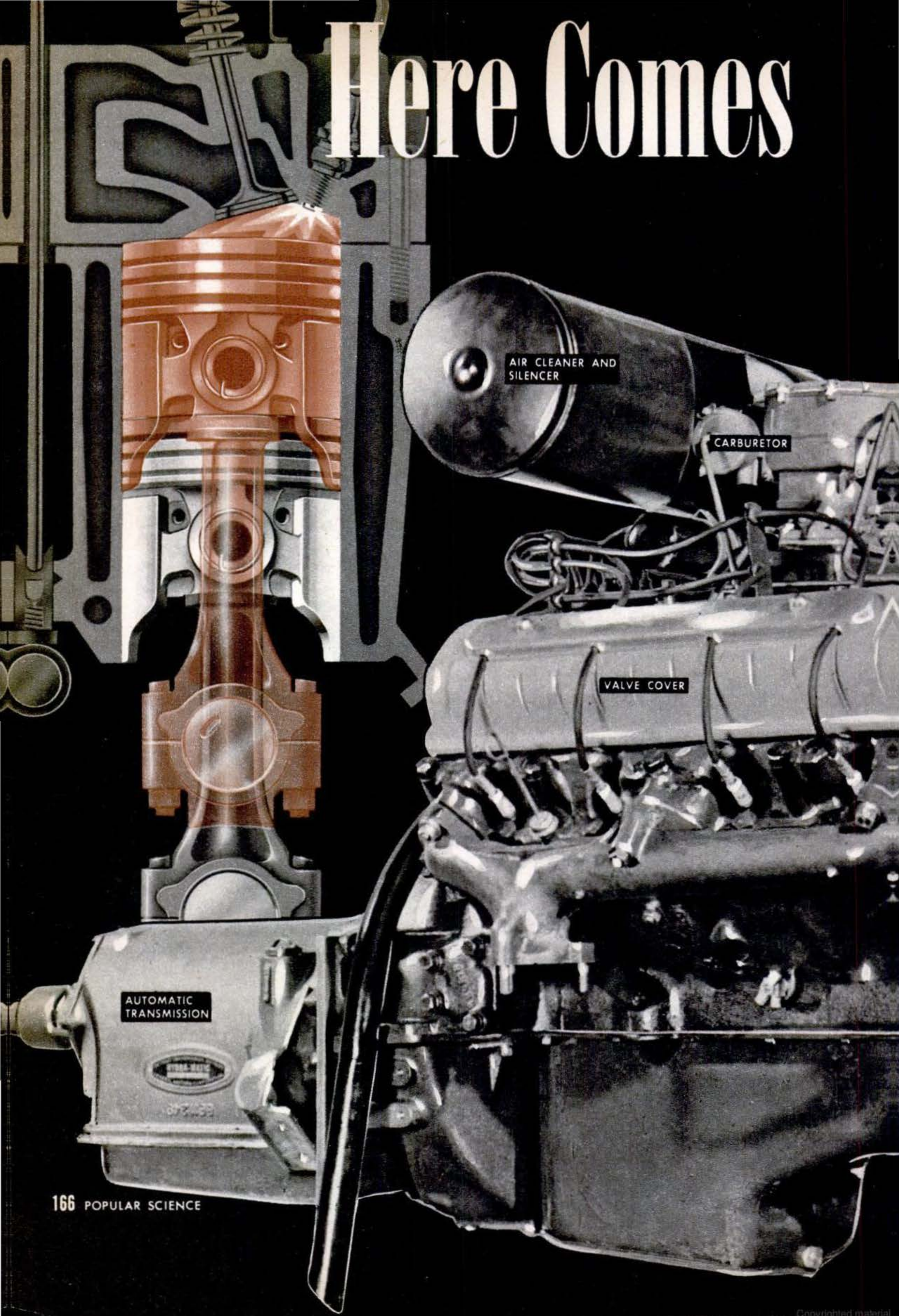
Here Comes



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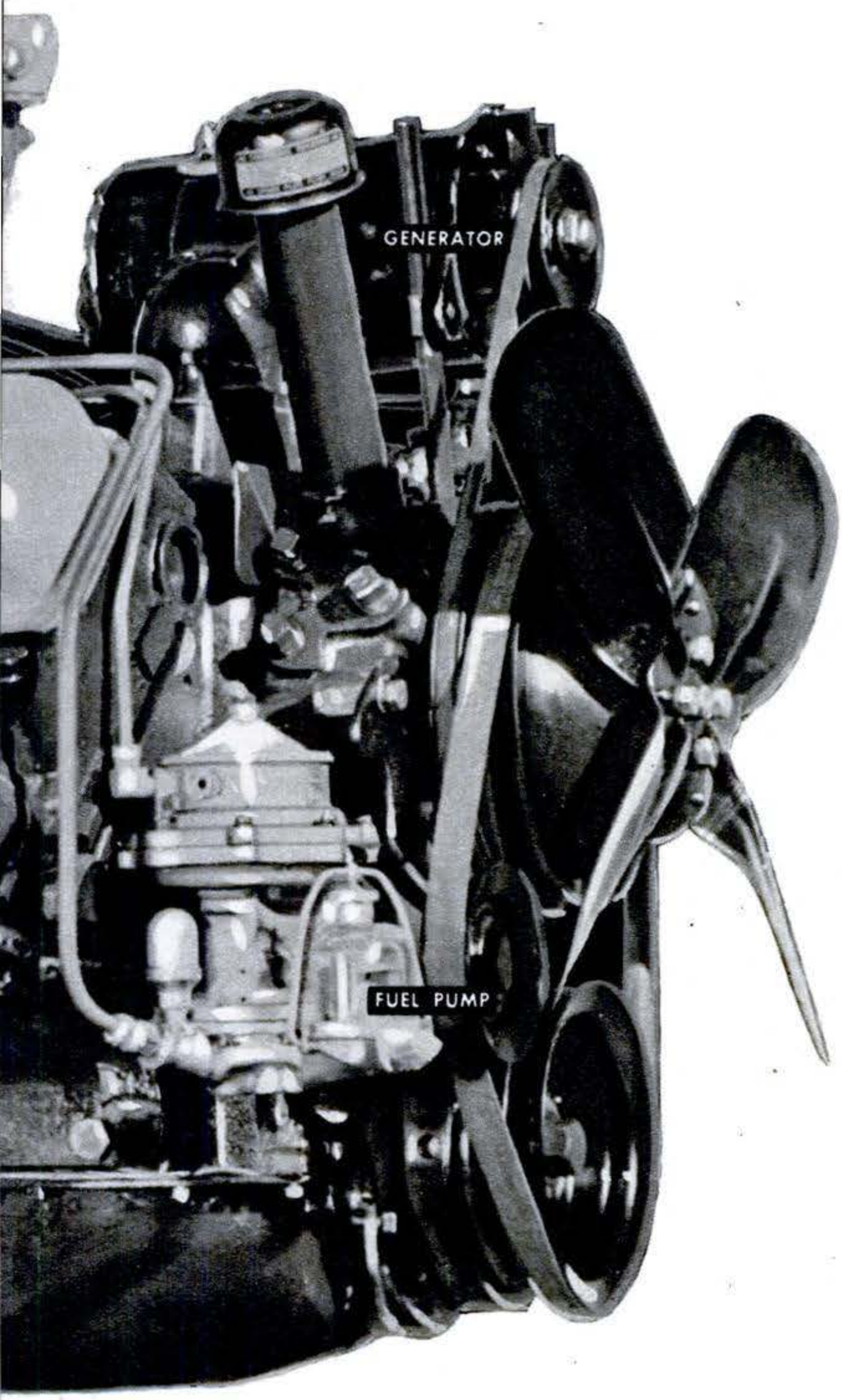
High Compression!

New Oldsmobile engine, designed for 12-to-1 ratio in future, looks ahead to tremendous savings in motorists' gasoline bills and lessened demands on nation's oil supply.



By Devon Francis

PS photos by W. W. Morris

FOR more than a quarter of a century U. S. motormakers and fuel distillers have been trying to squeeze a lot more power out of a gallon of gas. Late last month the Oldsmobile Division of General Motors announced it had taken a long step toward doing so:

Oldsmobile had produced a car with a 135-horsepower engine that can be modified for future models, with a minimum of plant retooling, to get 25 or more miles to the gallon in city traffic.

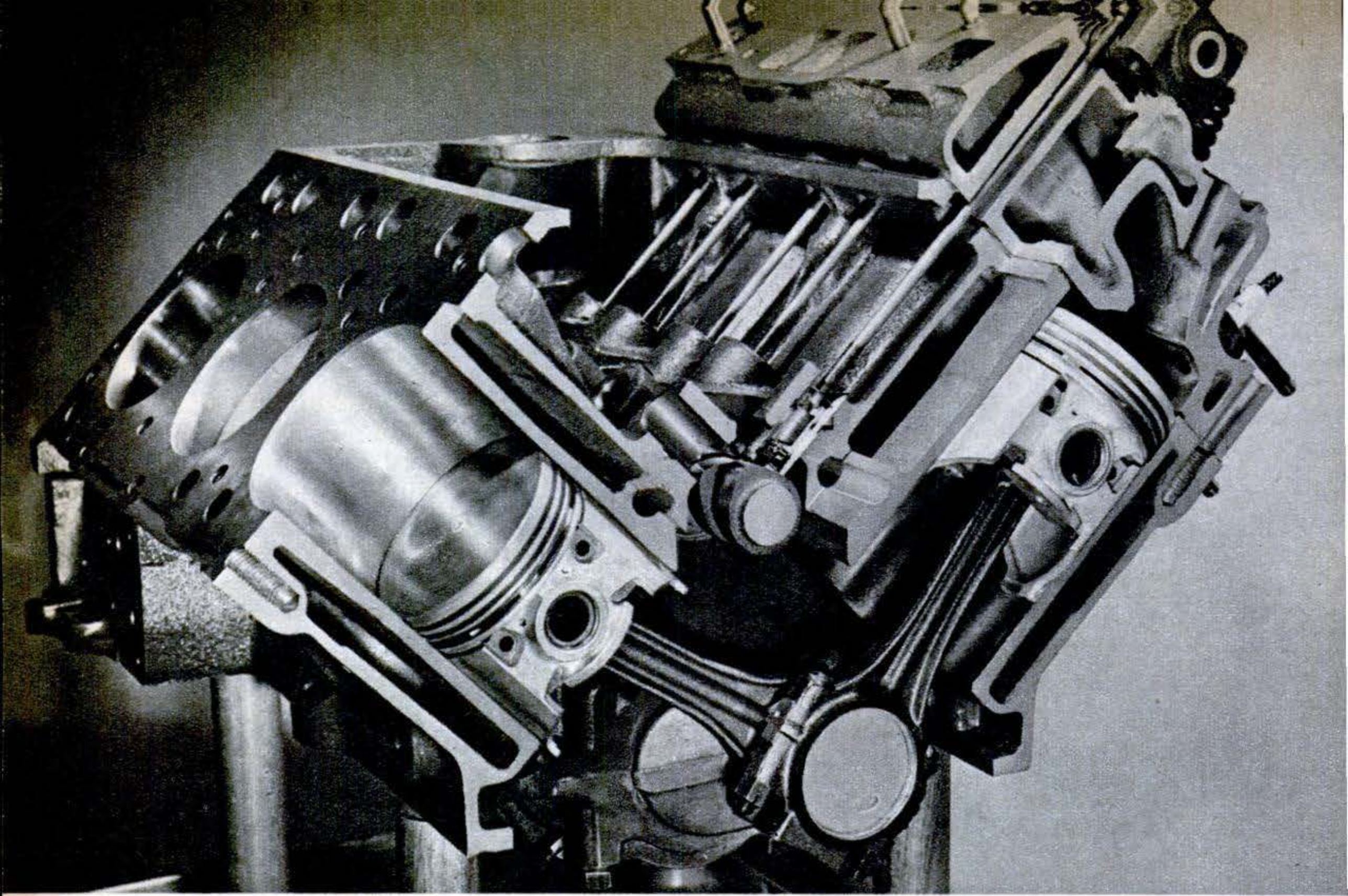
This is the so-called Kettering engine (PS, Aug. '47, p. 89), now brought to the production-line stage for the Oldsmobile's 1949 eight-cylinder models.

To the average motorist, beset by rising prices on filling-station pumps, the new engine looks like an answer to a prayer. But there is a catch: until the proper fuels become available country-wide, Olds customers will have to be satisfied with a mere fraction of the performance and economy of which it is capable.

Even so, the engine promises to pace a revolution in gasoline-fed automotive powerplants. It weighs less per horsepower than other car engines. Though delivering 135 hp., it gets more miles from each gallon of gasoline than its immediate predecessor of only 115 hp. It has added snap when the light turns green. It takes hills going away.

And for the future conservation of the nation's oil resources, the Kettering engine has a deep significance. *Extracting more power from available gasoline will be like finding one new oil well for every three that exist.*

The key to all this added power is the new



Cutaway view of new Oldsmobile engine shows its large bore of 3 3/4 in. and short 3 7/16-in. stroke. Engine weighs 5.52 lb. per hp. against 6.22 lb. for former in-line engine. Its compression ratio of 7¼-to-1 is not the highest, but compares with an average of slightly under 7-to-1 for most of today's cars. Piston displacement is 303 cu. in., to 257 cu. in. in the '48 Olds.

engine's high compression – plus expanded production of antiknock fuels (PS, June '46, p. 124). Hence the term used to describe the engine fundamentally explored by the grand old man of GM research, Charles Franklin Kettering–*high compression.*

Developing this engine has taken a long time. The lag was the fault of current engine and fuel development.

Compression ratios – which mean how much a charge of fuel in a cylinder is compressed before it is exploded – have been edging upward for 20 years. They have gone from 4-to-1 to better than 7-to-1. This represents real, hard-won progress. But compared with what the car manufacturers have been shooting for–compression ratios up to 15-to-1–the progress was peanuts.

It was Kettering–"Boss Ket," to everybody in the automotive business–who finally took the grunts out of higher compression. Up to late in 1945, when he began puttering with them, high-compression engines were rough enough to shake themselves into a heap of spare parts. They pinged, gasped, got hot.

At GM's Research Laboratories Division in Detroit, Ket built a stiff, heavy, 6-cylinder engine that purred right up to 15-to-1.

Engineers of GM's Oldsmobile Division, in Lansing, Mich., originator of the Hydra-Matic® transmission, decided that the principles of the experimental engine could be adapted to production. Their target was an immediately usable 8-to-1 ratio in an engine so designed that, with only minor retooling, they could modify it in the future to boost the compression to 12-to-1. It was no small job they cut out for themselves. Developing an engine that comes very close to the mark took the next two years.

In burying the myths about high compression, Kettering had disposed of the prevalent idea that an engine would have to be light and flexible to absorb the power produced by better fuels. He had proved, on the contrary, that engines had to be *stiff*. Cylinders had to remain round, not be pulled microscopically oval by the stress of tightening down the head on the block. Most of all, the crankshaft could not bend. If it did, the

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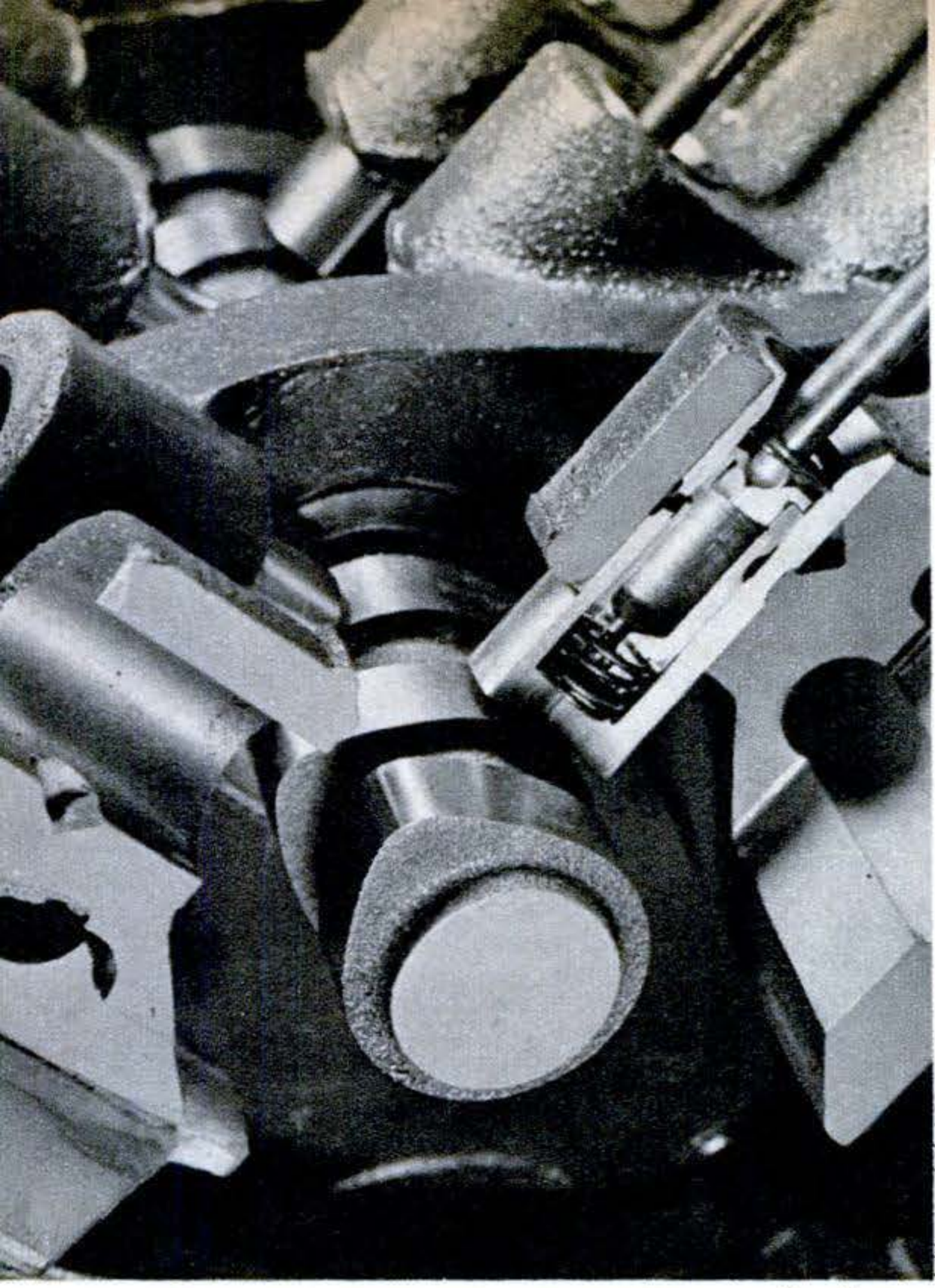
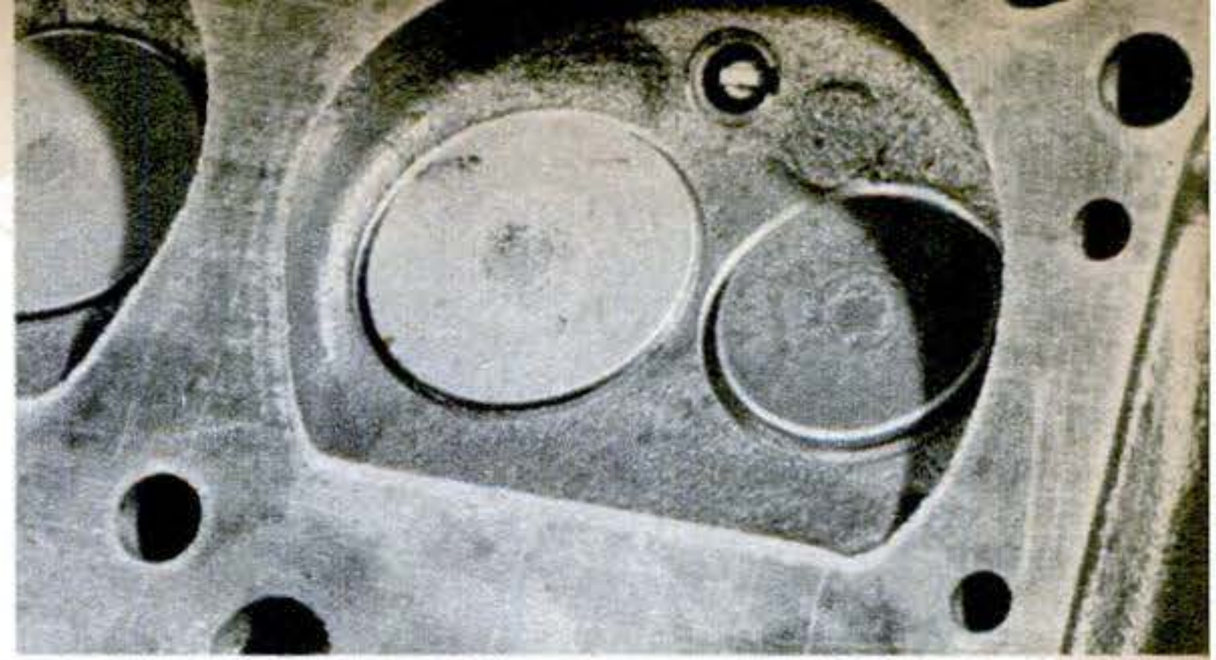
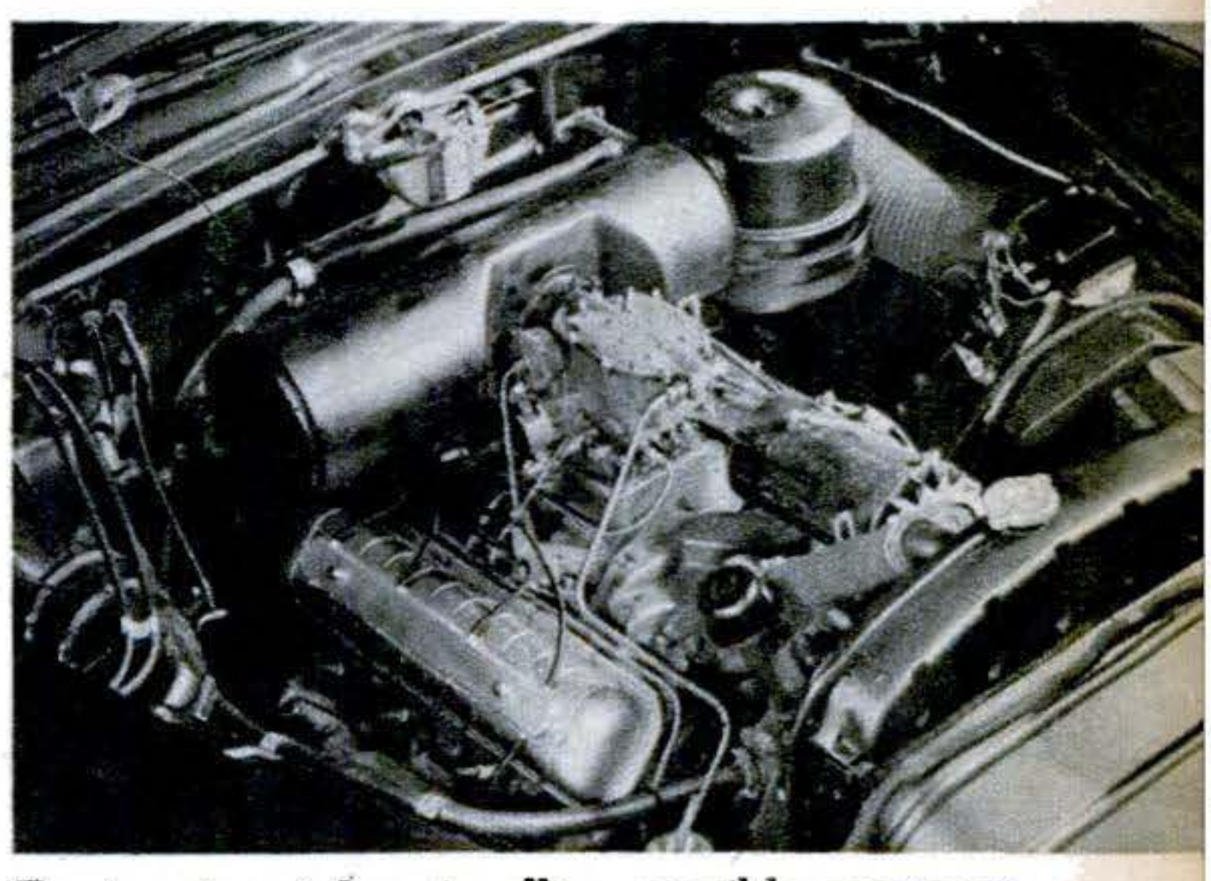


Hydraulic valve lift, cut away at right, keeps down noise. For extra cooling of crankcase oil, passages at both sides of camshaft let it gush up against inside walls of the water jacket.



Intake valve, left, has diameter of 1 3/4 in., 3/16 in. more than in-line engine's; 1 7/16-in. exhaust valve is 1/64 in. smaller than in '48.



Engine is set low to allow possible rearrangement in change to higher compression. To prevent starving any cylinder, intake manifold has separate passage to each from carburetor.

bearings would bind, and friction would eat up the advantages of high compression.

All that seemed to call for more weight. How could Olds keep it down?

Then there was another problem. The size of the combustion chamber had to be shaved to increase compression. Olds was wedded to the L-head engine. Fuel came out of a long gallery on the side of its 8-in-line block and was piped around turns into the side of the head. But the minute you ground down the size of the combustion chamber in an L-head engine, you rapidly began losing volumetric efficiency—a fancy term for the ability of a cylinder to inhale a charge. In an L head, the outside air just couldn't push hard enough to get sufficient gas into a cylinder for high compression.

The possibility of an F head, with the intake at the top of the cylinder and the exhaust port on the side, was discarded quickly. It would make too big a mechanical package. That left the overhead valve as the inevitable solution. To keep the engine from clicking like a subway turnstile when it was cold—overhead-valve engines are notoriously noisy—hydraulic valve lifts were adopted to compensate for play between the parts.

The most important problem — how to stiffen the crankshaft—was neatly solved by abandonment of the in-line engine that Olds had used for 17 years. By going to a 90-degree V-8, the designers shortened the shaft.

As for weight, they discovered that stiffening didn't have to mean bulk. By chipping away here and there, the weight of the new V-8—a type of engine normally heavier than an in-line—was kept within reasonable limits. The new engine still weighed more in pounds —but less in *pounds per horsepower.*

From Kettering's work, Olds was satisfied that, apart from engine stiffness, the nub of its high-compression design would be a big bore and short stroke. That would keep down piston speeds and losses from friction. But there still were other details to work out.

Olds continued use of aluminum pistons, which are ideal for dissipating heat.

The new engine couldn't afford a "hot valley," characteristic of some V types, if—

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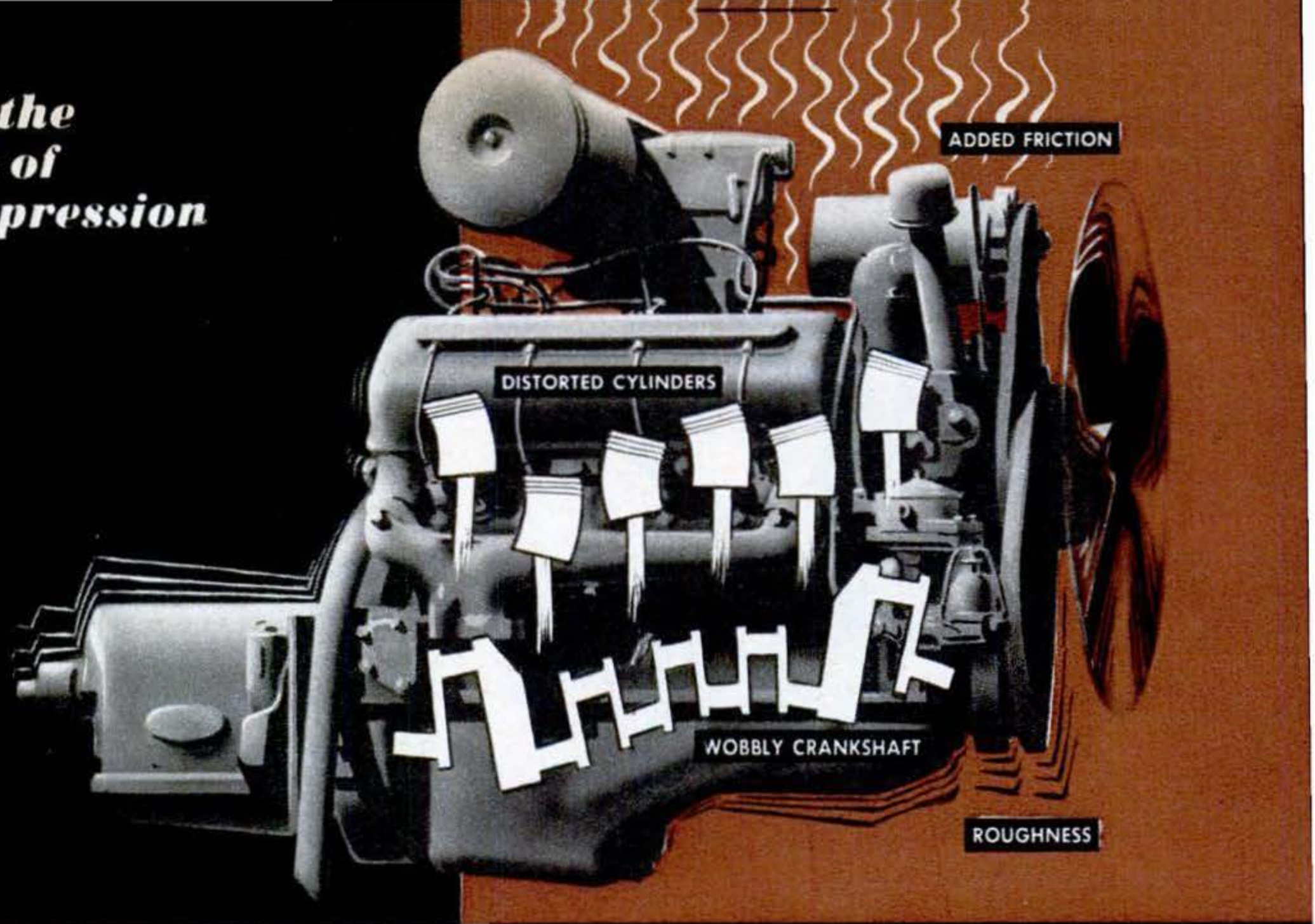
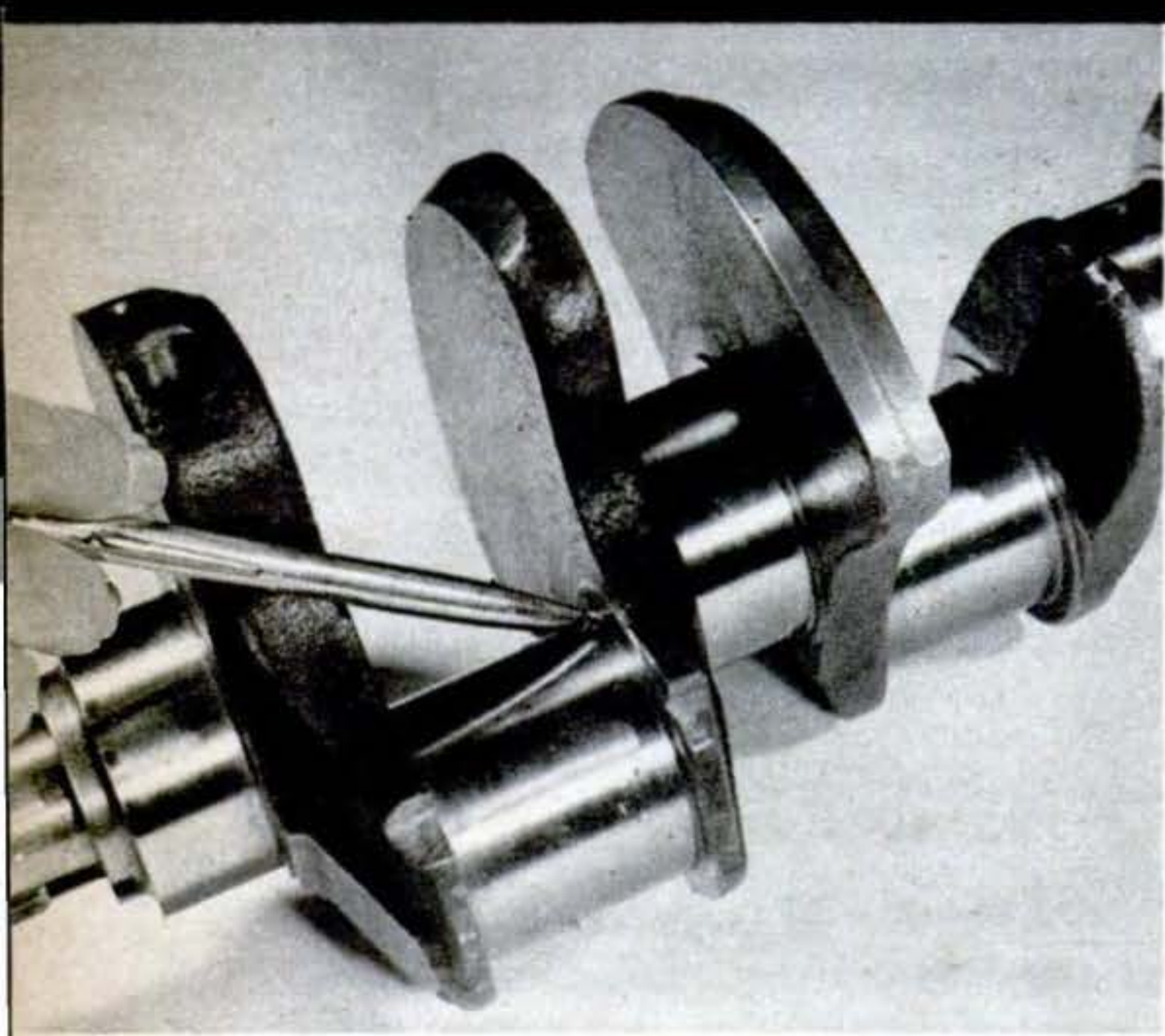
Here are the problems of high compression





Overlapping diameters of rod and main bearings stiffen crankshaft, cut friction from bending. Peak firing pressure in new engine is 650 lb. per sq. in., compared with last year's 600 lb.

Aluminum piston has more rugged ribbing than 1948's. Though it has only three rings, instead of four, increased stiffness of cylinder gives a better gas seal. Pins have a diameter of 1 in.

in the future—it was to use fuels extremely sensitive to heat. So the exhaust collector pipes were put on the perimeter of the block. As a result, intake air is some 20° cooler than in the old in-line engine.

Having achieved a quiet engine, the engineers didn't want to louse up everything with air-intake noises. Hence the rather elaborate silencer for their new engine: a one-way trap for sound that smothers intake noises in a series of "tin cans" tuned to the frequencies in the manifold.

The second part of the problem posed by high compression—fuel—is hitched to the pressures developed in the engine and the heat produced.

The why of high compression is that it produces more *usable* heat. All automobile engines waste heat—and fuel (PS, Sept. '48, p. 98). Most get less than a quarter of the power available in every gallon of gasoline that goes through them.

A high-compression engine wastes fuel, too, but it wastes less and gets more work

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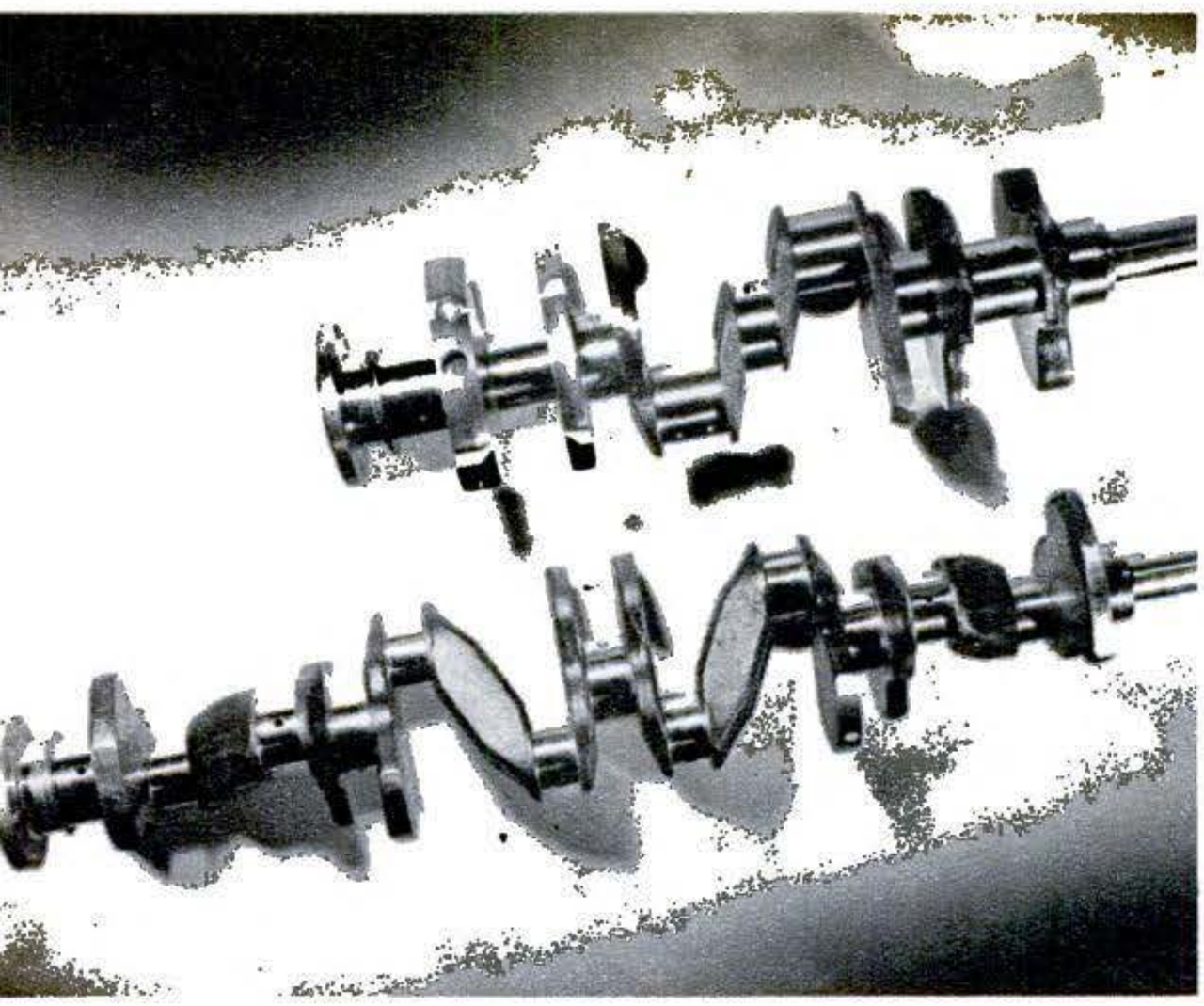
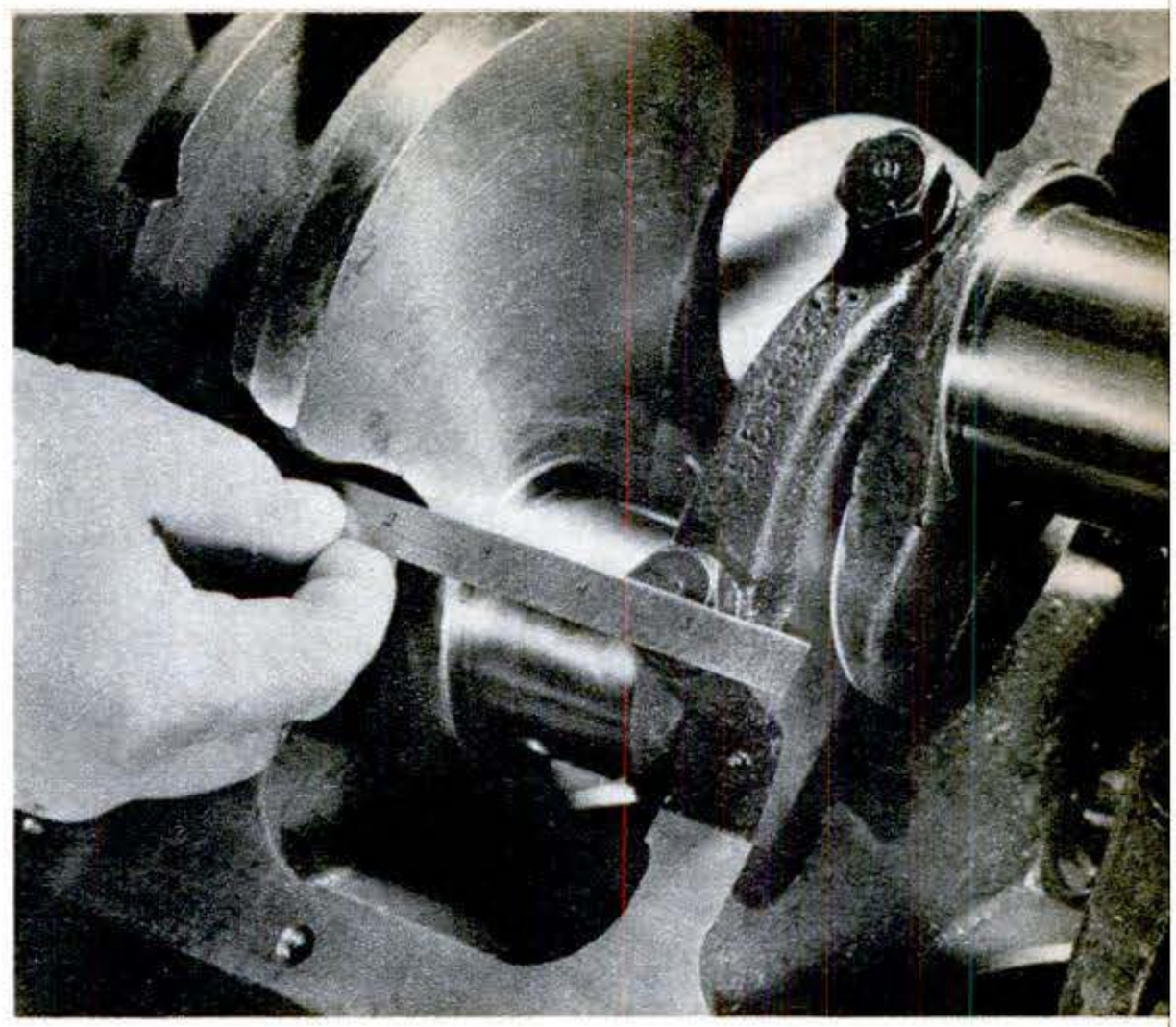
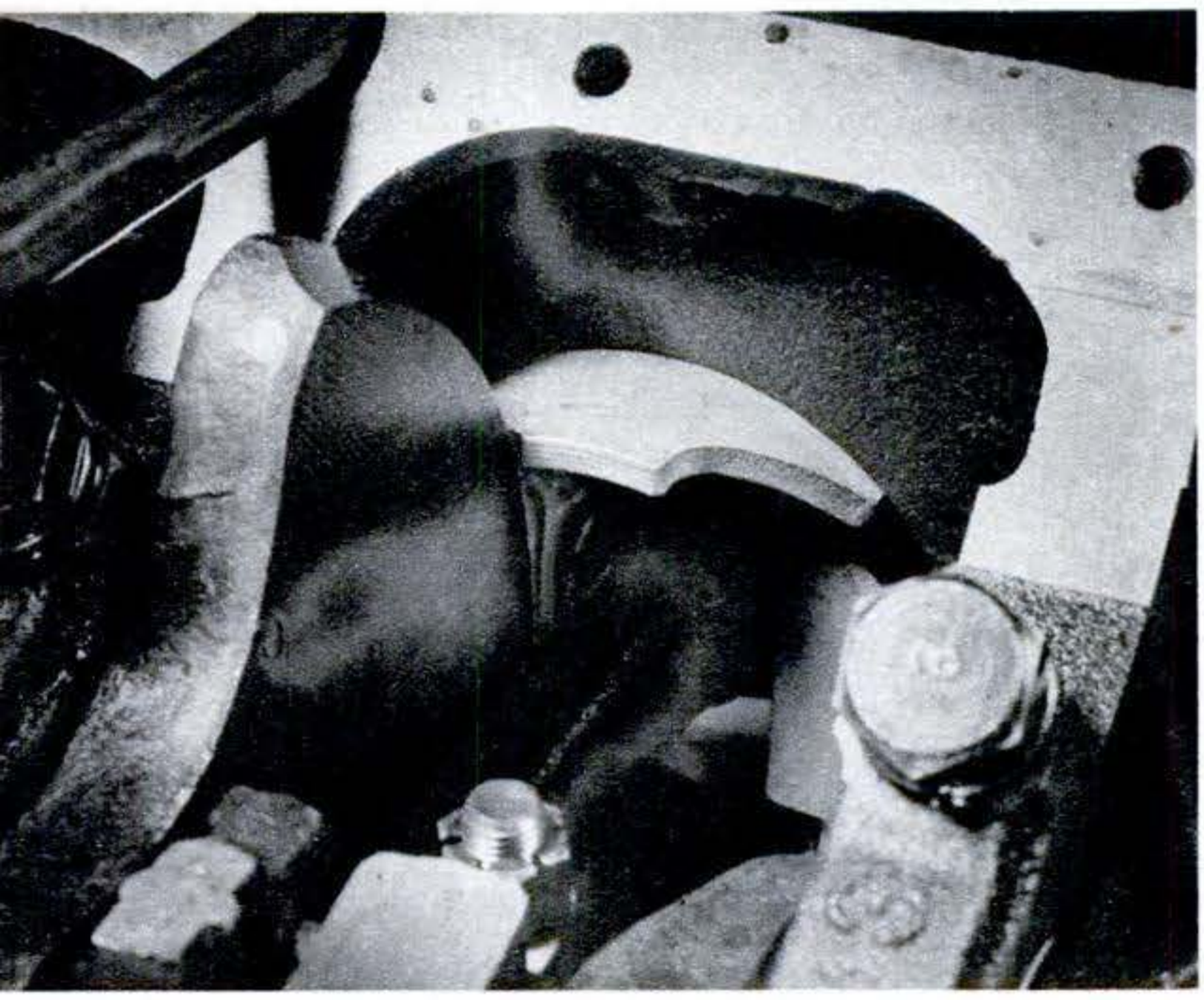


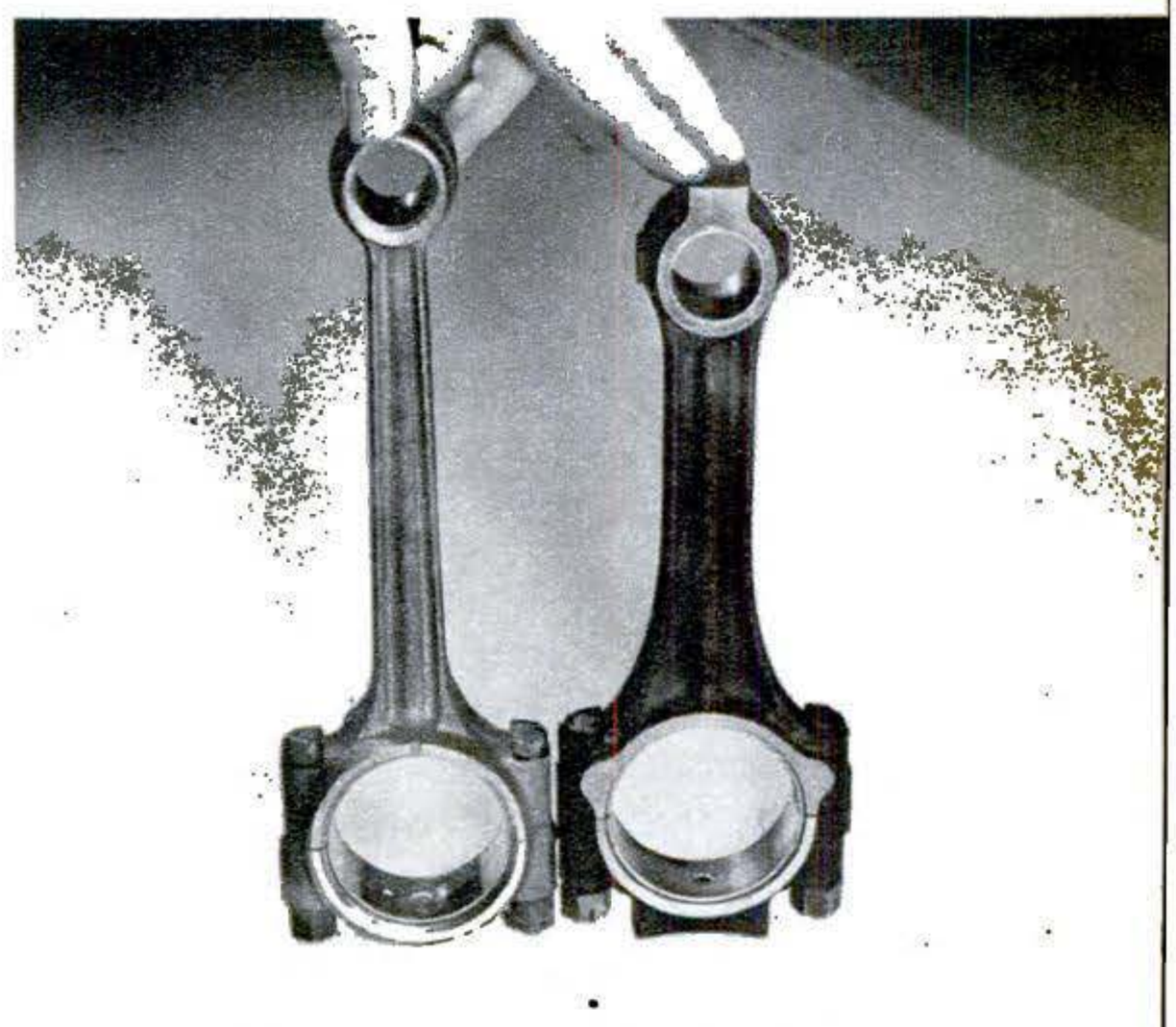
Five-bearing crankshaft (top) is sharp departure from standard use of three main bearings in V-8s. Crankshaft is 26 7/16 in. long, a reduction of 12 3/4 in.; entire engine, 33 1/16 in.



Reduced bridging between main bearings also stiffens engine. New V-8 bearings are 4 5/8 in. apart, against 8 1/16 in old engine. Four of bearings are 2 1/2-in. diameter; fifth, 2 5/8 in.



To keep engine compact, piston skirts are cut out to clear crankshaft counterweights at bottom of stroke. Despite greater side load on piston from more thrust, friction loss is less.



New rod (right) is shorter, stiffer. I-beam section is 1 in. wide, compared with 5/8-in. width of old rod (left). Thickness remains the same. Rod bearings are 2 1/4 in. in diameter.

done. It burns up the gasoline more completely and uses it to impart a harder push to the pistons. Less of the heat is dissipated wastefully through the radiator.

The burning gas in a high-compression engine *expands* more as it pushes on the pistons. That's where the efficiency comes in—in the *expansion ratio.* The expansion ratio keeps step with the compression ratio.

The only way the automobile owner gets knock-free performance out of a high compression ratio is to use fuels tailored to its needs—either at the refinery or by special injectors. These special fuels help to do away with detonation—what happens when a fuel explodes all at once instead of burning slowly enough to push the piston smoothly.

Even so, a high-compression engine doesn't ask too much of its fuel. Olds' 1949 engine will operate nicely on premium gasolines now generally available. A compression of 8-to-1 would require 91 to 93 octane, and 12-to-1 around 100 octane. Research is expected to increase the supply of such fuels.

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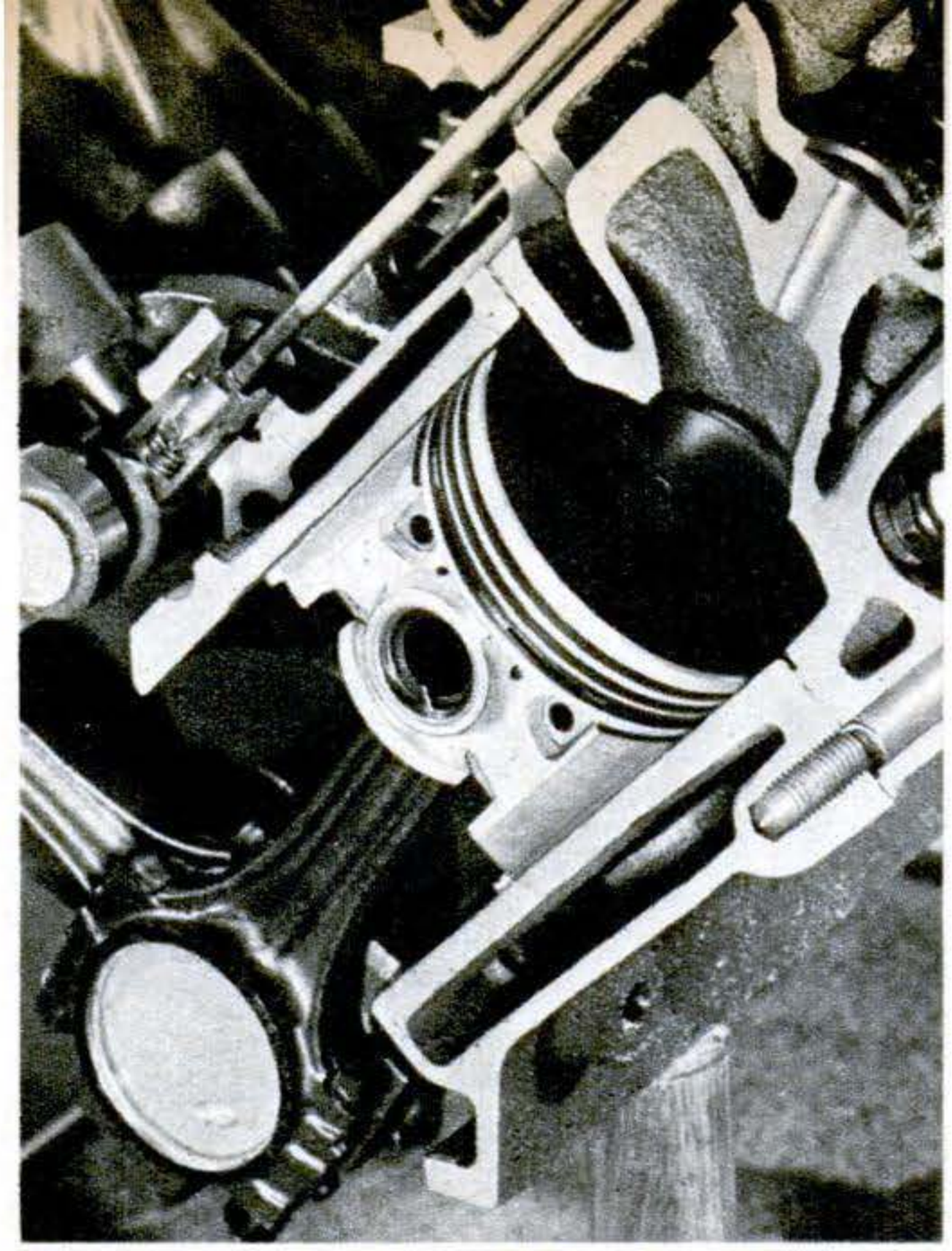
PERFORMANCE		
OLD		NEW
19	MILES PER GALLON AT 25 M.P.H.	20.5
14	MILES PER GALLON AT 60 M.P.H.	15
44.5	CLIMBING SPEED IN M.P.H. ON 11-PERCENT HILL IN THIRD GEAR	51
22	ACCELERATION IN SECONDS FROM 20 TO 60 M.P.H. IN FOURTH GEAR	17.5
88	TOP SPEED IN M.P.H.	94.5

Savings in fuel costs would total $250,000,000 a year and savings in gasoline at least a billion gallons, one oil company estimates, if all U. S. passenger cars had engines like new Olds.



Combustion chamber will be reduced from 86.5 cubic centimeters in new engine (above) to 38.7, piston displacement from 303 cu. in. to 288, in ultimate modification to 12-to-1 compression.

For experimental purposes, oil companies are ordering new Olds engines with heads permitting 8-, 10-, and 12-to-1 compressions.

Up to now the oil companies have met inquiries about higher octane numbers with the reasonable answer that it would take an awful lot of money and steel to build the equipment to make super-gasoline in the quantity proposed.

They're coming, though. Antiknock ratings – octane numbers – on standard gasolines climbed from 55 to 75 between 1927 and the start of the war. Automotive people in the know say they will edge steadily upward in the next two or three years.

Oldsmobile is now set to keep pace.

And this preparedness has been obtained with no sacrifice of other desirable factors. Olds' new engine, being produced in what probably is the industry's most beautiful plant, is powerful, economical, and smooth. It is almost vibrationless. The engineering figures on its performance—obtained under ideal laboratory conditions, of course—are impressive. To transmit and absorb its greater power, the plates in Olds' automatic clutch have been increased from 9 to 11 pairs and the axle ratio has been reduced from 3.9-to-1 to 3.63-to-1.

And yet Olds isn't satisfied. The engine's compression is only 7¼-to-1. The engineers had to retreat from their goal of 8-to-1.

"It's hard to get the proper fuels as yet for an 8-to-1 engine," an Olds official explained to me, "except on the East, Gulf, and West coasts." Then, as an afterthought: "Besides, the engine as it stands has plenty of power. If we added any, the wheels would spin on wet pavement."

Olds is convinced that the next step—when another increase in compression becomes possible—is to pour all of the benefits from it into fuel economy.

But it is not convinced that compressions will stop at 12-1. All it knows is that the benefits of high compression right now begin to level off in its engine at 12½-to-1. It figures that an eventual 12-to-1 is high enough to plan for now.

Cadillac for 1949 is nudging just a bit higher than Olds.

Olds is keeping an open mind. The other day an Oldsmobile owner in Australia wrote in to say he had ground down his engine head until he had a compression ratio of 9-to-1. Now he wanted even more power. What could the factory suggest? A subordinate asked an Olds official what to do.

The official grinned. "Hire him!" he shot back. END

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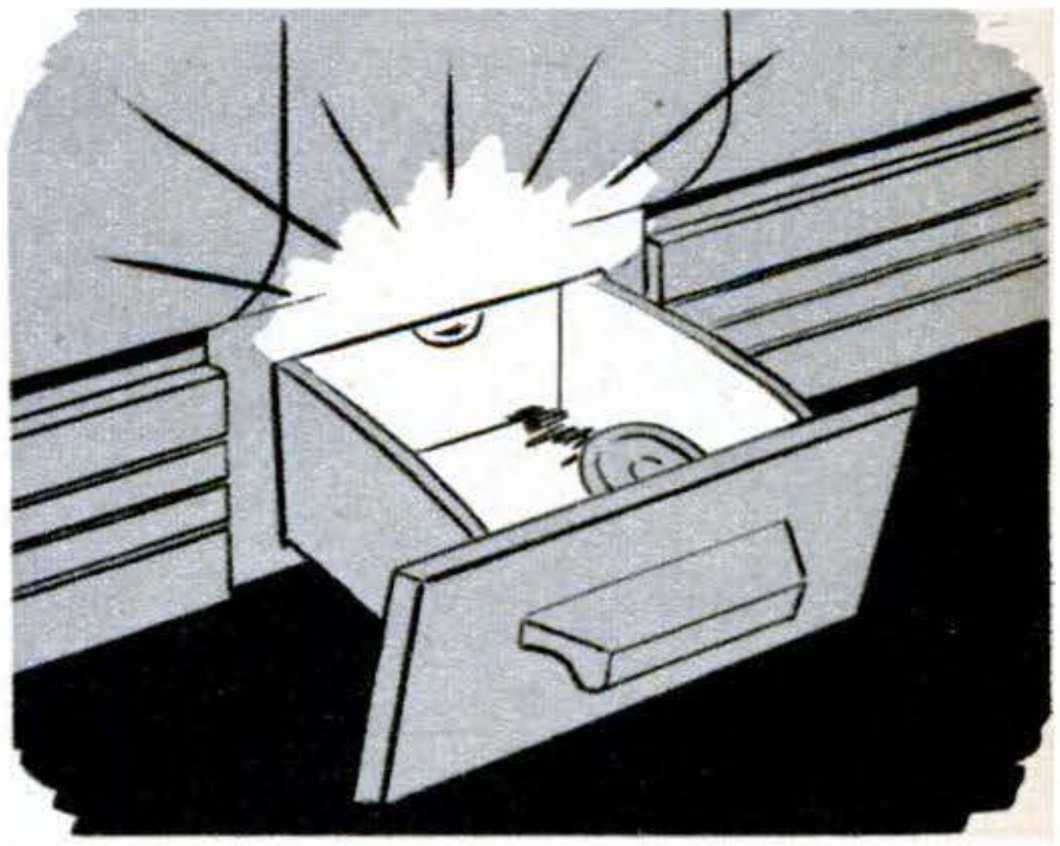
I'd like to see them make . . .

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science* will pay $5.00 for each one published. Use government postcards only. Contributions cannot be acknowledged or returned.

Leaders on typewriter ribbons. If each—or at least one—end of typewriter ribbons had an uninked, plastic leader, you wouldn't get your hands so dirty when putting them on the machine.—*E. R. Skilton, Watertown, Conn.*

Disposable paper bath mats. These could be sold in rolls like paper towels. They probably would have to be a little thicker than the towels and they should be in colors.—*Mrs. Carroll Cormier, New Orleans, La.*



Lights for ash trays in the rear seat of cars. Usually there's enough light so you can find the tray on the dashboard, but the rear-seat passenger has to grope around for it.—*Marvin Torgeison, Comstock, Wis.*

A balance for cake tins. Layer cakes, to be made properly, must have an equal amount of batter in each layer. A simple balance would compare two tins and assure you of an equal amount in each.—*W. B. Weeden, Wakefield, R. I.*

Push-up bottoms in measuring cups. As it is now, when you measure shortening for a recipe, you have to dig it out with a spoon. A push-up bottom would be quicker and not as messy.—*Geraldine McKenzie, Pittsburgh, Pa.*

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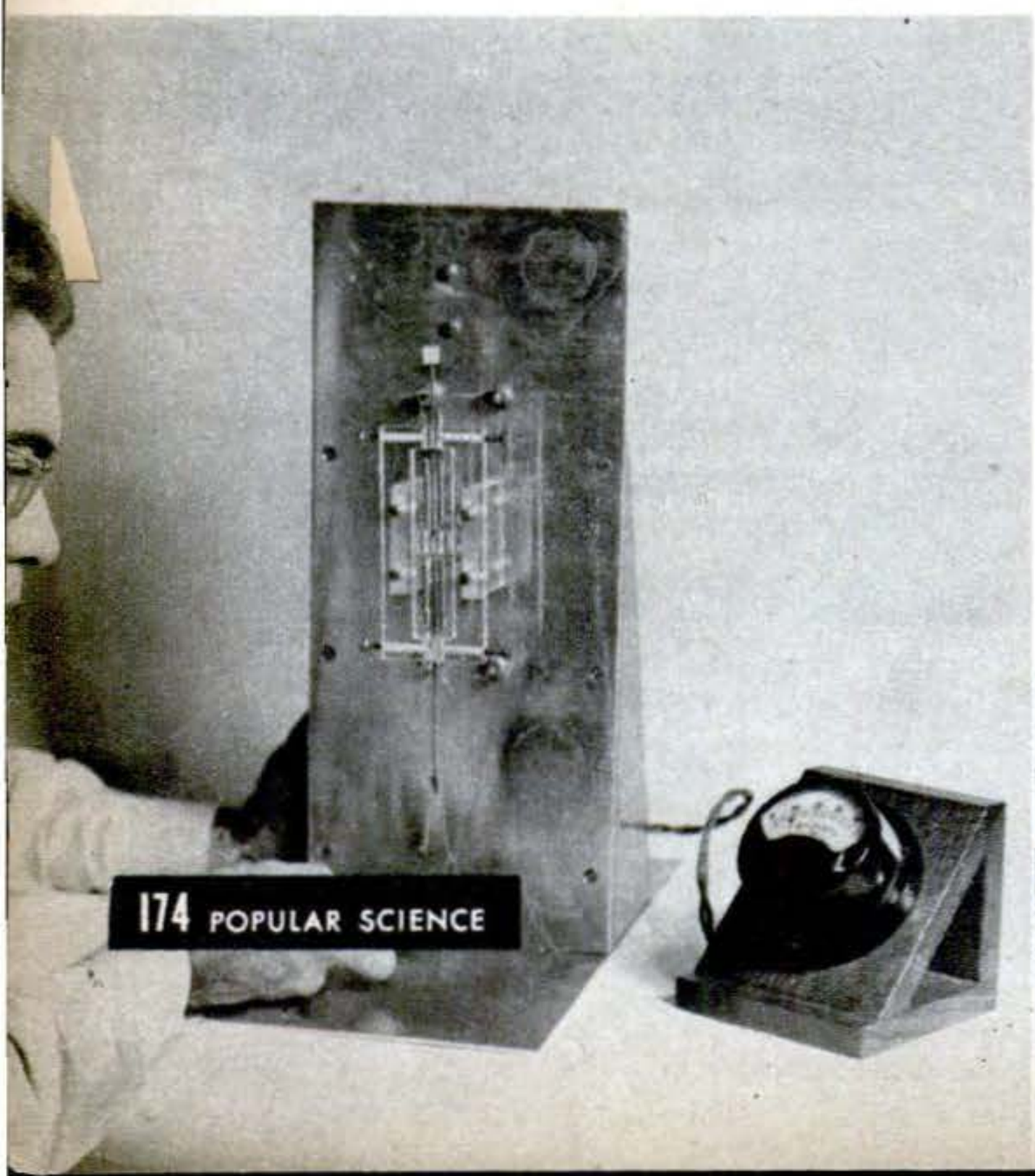
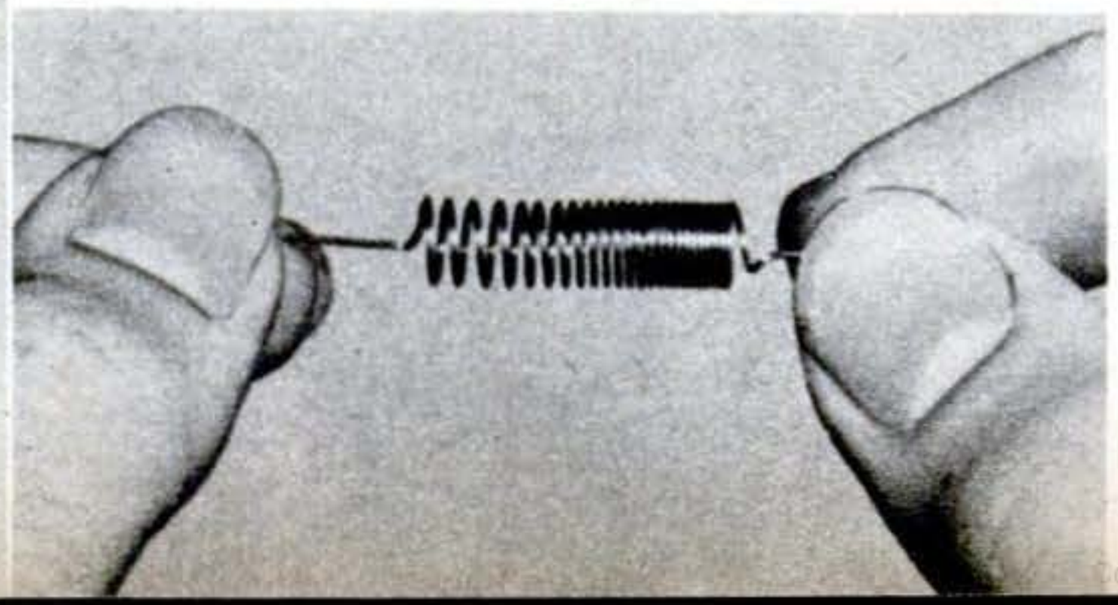
Biggest Ingot. This giant red-hot "H" ingot, weighing 452,000 pounds, is about the largest single piece of steel you'll ever see. Made by Carnegie-Illinois Steel, it will be forged into a side yoke for Carnegie Tech's new 1,900-ton cyclotron. The 400-million-electron-volt cyclotron is designed to increase the production of elusive meson particles.



Spring Measures Movements. Movements of as little as .00001 in. can be detected by a trick spring called a transducer (below) whose turns pull apart one by one. Closed, it has the electrical resistance of a metal tube; completely open, its resistance is that of the length of wire. Stretched (left), minute changes in its length multiply changes in its resistance hundreds of times. Measuring these resistance changes measures tiny movements of objects attached to the spring. The Bureau of Standards developed the method.



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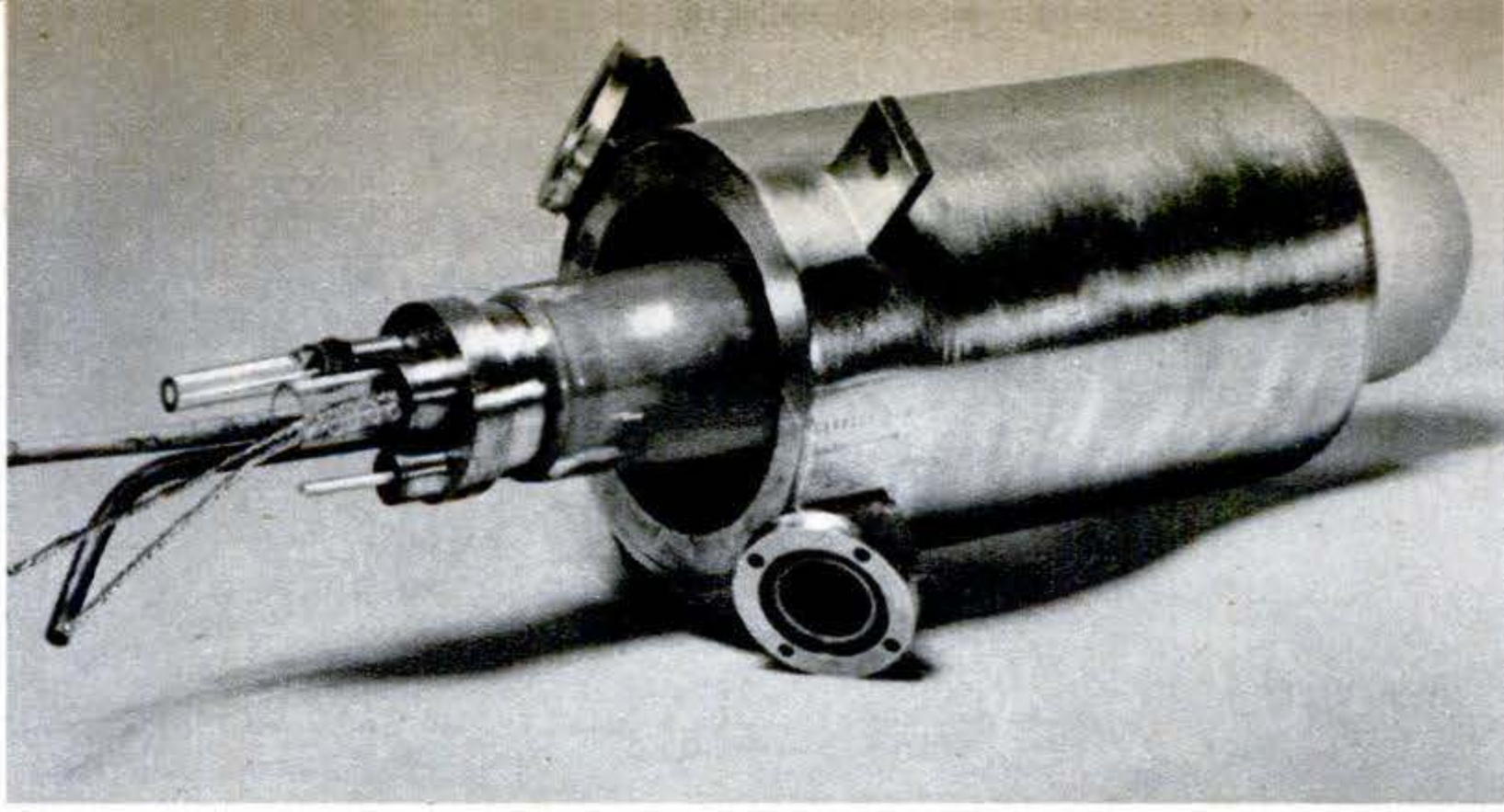

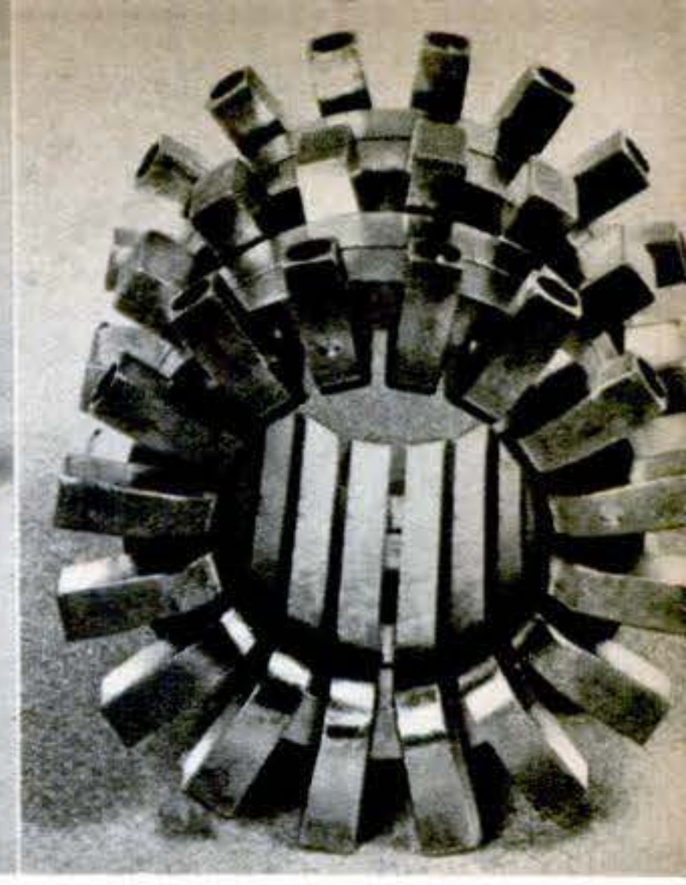

50,000-Watt Magnetron Tube. The odd-shaped objects above are parts of the most powerful magnetron tube of its type in the world. Ten times stronger than any other such tube, it has a continuous-wave output of 50,000 watts. Its frequency, a billion cycles per second, is 1,000 times that of a standard broadcasting station.

When the tube is assembled, the cathode at left fits into the anode at right. Each of the anode's vanes is individually water-cooled. The ceramic dome at the right end of the cathode houses the antenna from which the tube's energy is radiated. Made by GE for the Signal Corps, the new tube will be used for specialized communications.

Rare Gases Aid Research. Scarcest-of-all isotopes of the two most fundamental kinds of matter, hydrogen and helium, now are being distributed to scientists, hospitals, and research centers by the AEC.

Hydrogen 3 or "tritium," a radioactive gas of which a vial is shown below being packed for shipment, is valuable as a "tracer" in medical and chemical research. Even rarer than hydrogen 2 or deuterium, which forms heavy water, tritium forms "extra-heavy" water—another important research tool. Helium 3, an extremely rare stable gas, is expected to yield clues to the properties of the nucleus.

Mirrors Test Light Globes. General Electric engineers are using mirrors to test the efficiency of light globes. To make sure a globe is putting its light where it is needed most, they rotate a large, angled mirror completely around it.

The mirror, shown below reflecting the engineer, reflects the globe's light to a sensitive electric eye 25 feet away. As the mirror is moved, the eye measures the light's intensity at each point around the globe, indicating whether the light is being distributed uniformly or not. The globe being tested below is for a streetlight.

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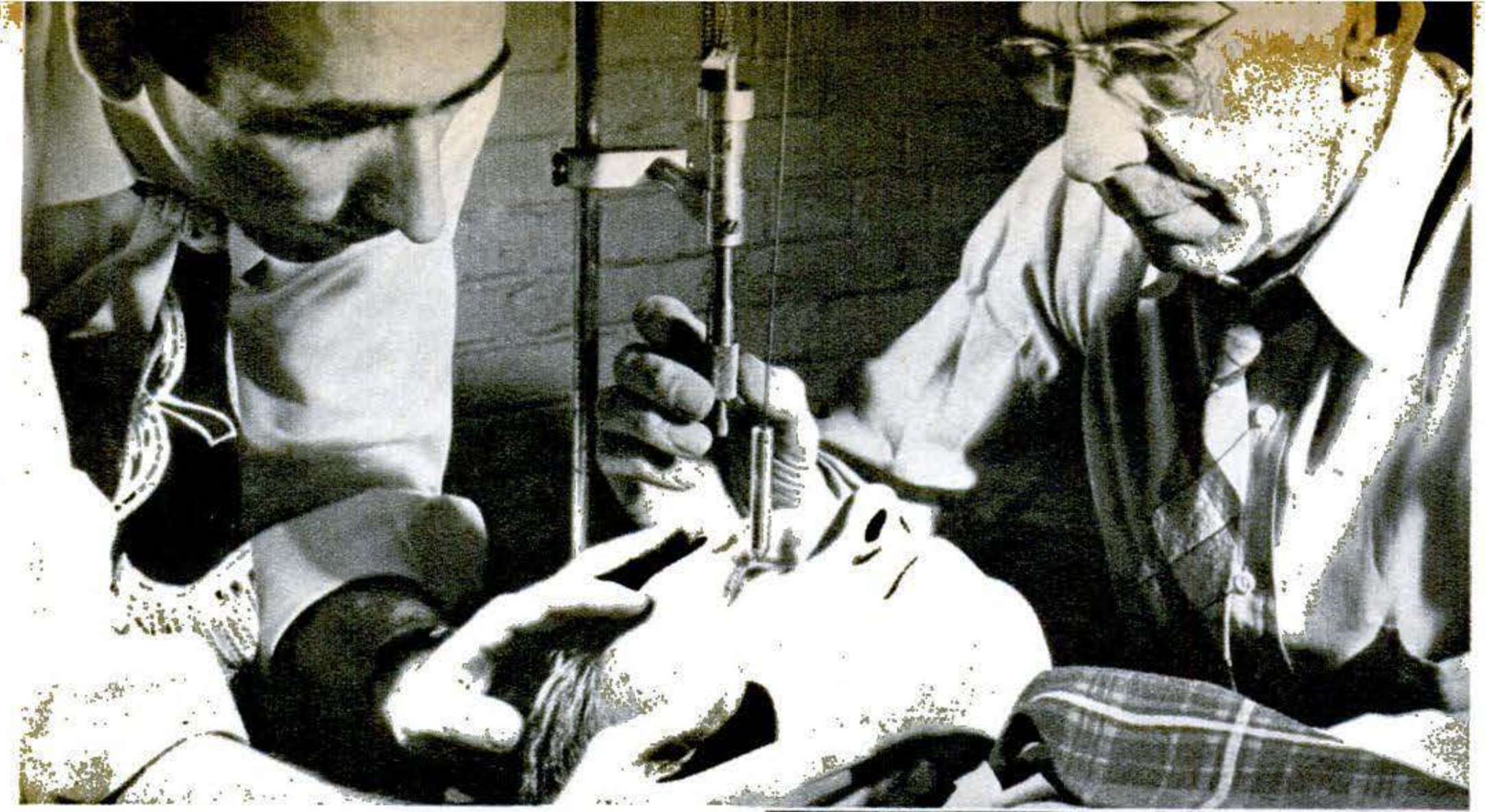
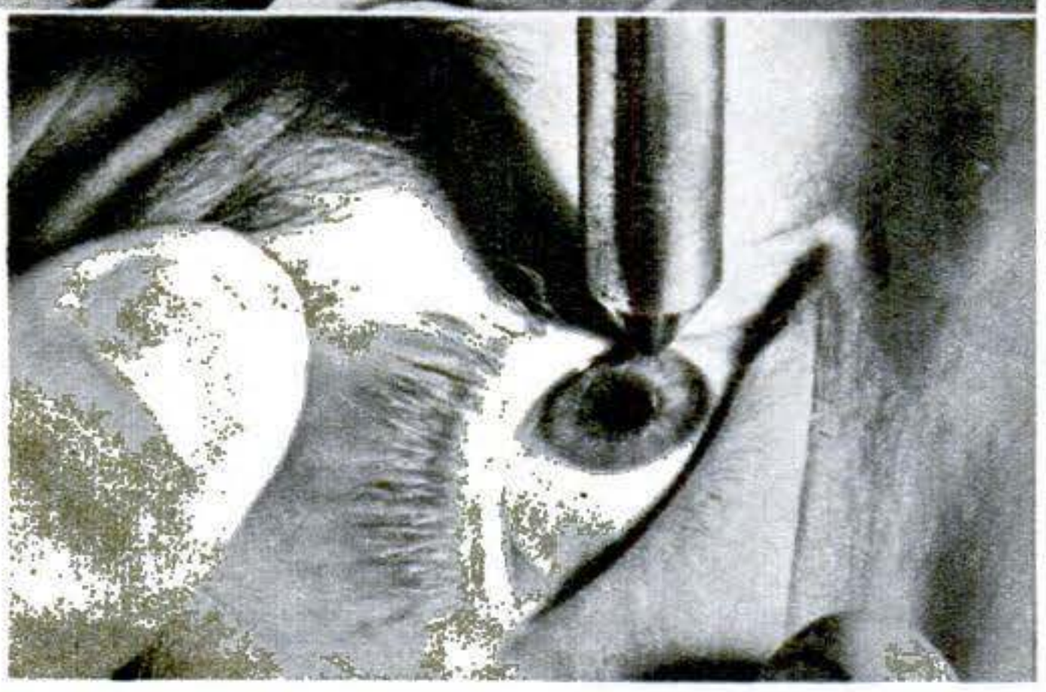


By lowering a warm brass cylinder to touch the cornea of volunteer's eye, psychologists found that it is insensitive to heat and cold. Reason is that it has no blood vessels, and heat and cold sensations result from effect on nerve endings of expansion and contraction of blood vessels.

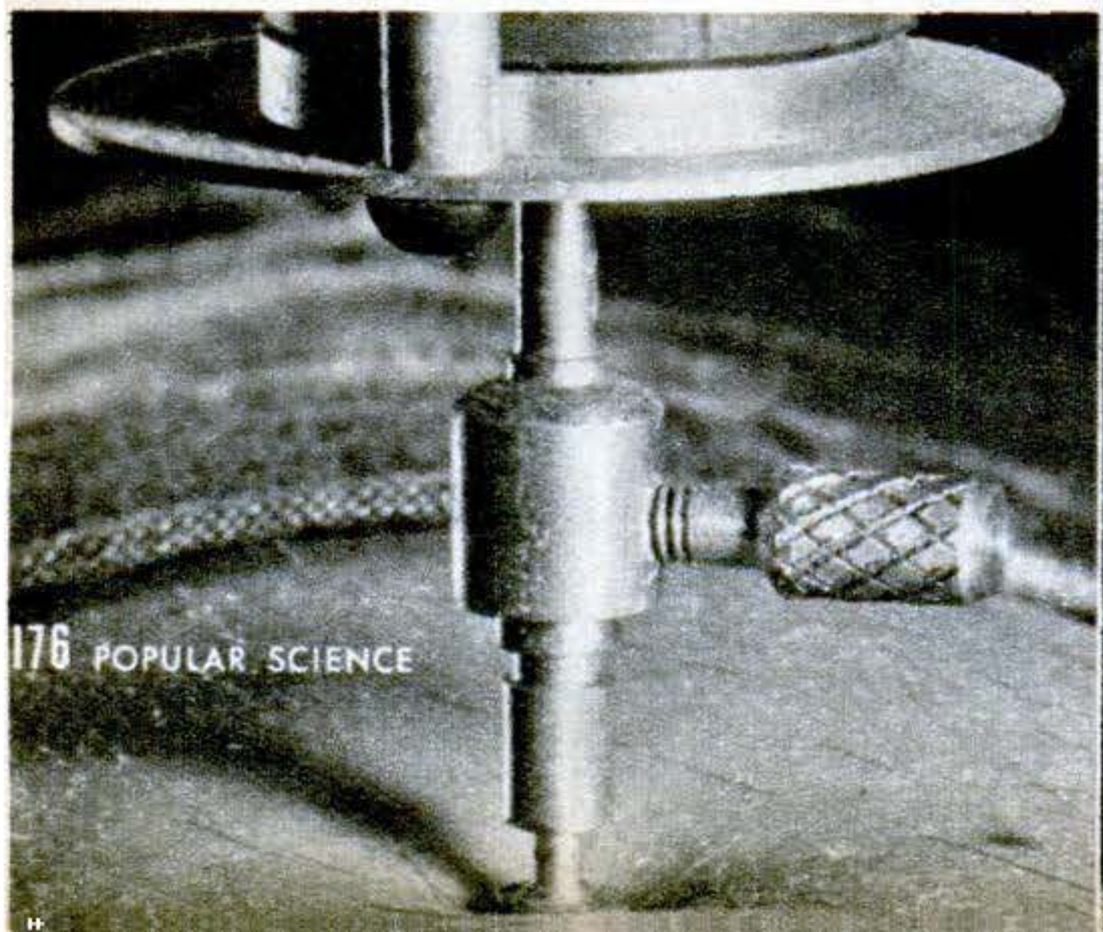


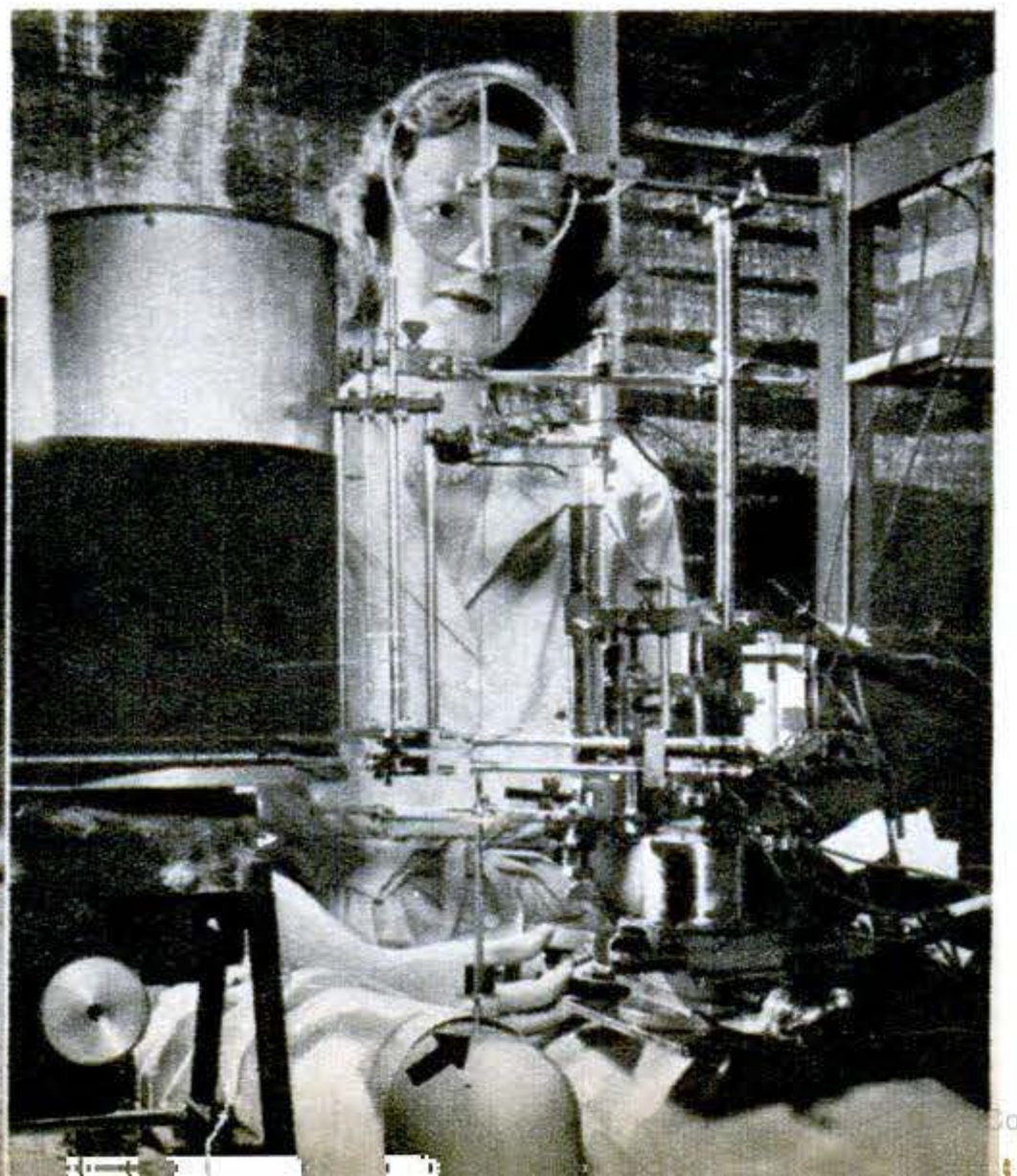
Ticklers Test Your Nerves

JUST *how* you feel heat, cold, pressure, and pain is being learned with some tricky mechanical gadgets developed at Washington University in St. Louis. There a group of psychologists headed by Dr. John Paul Nafe is using an instrument that drops a small weight on the flesh of a volunteer test subject and measures how deep the weight presses into the flesh, when the weight stops, and when the subject no longer feels the weight. In another instrument, reactions to heat and cold are tested with a warmed brass cylinder.

Results of these tests, reports Dr. Nafe, tend to disprove the old theory that the body's different types of nerve endings are each sensitive to only one kind of feeling. He believes that movement of tissue over the nerve endings causes sensation, different kinds of movement causing different sensations. When the movement stops, the feeling disappears.

Machine at right drops weight on flesh (below) to learn how people feel pressure. Big drum on machine records subject's reaction. New theory derived from these tests blames all feeling on movement of tissue caused by the weight, holding that nerve endings respond only to motion.





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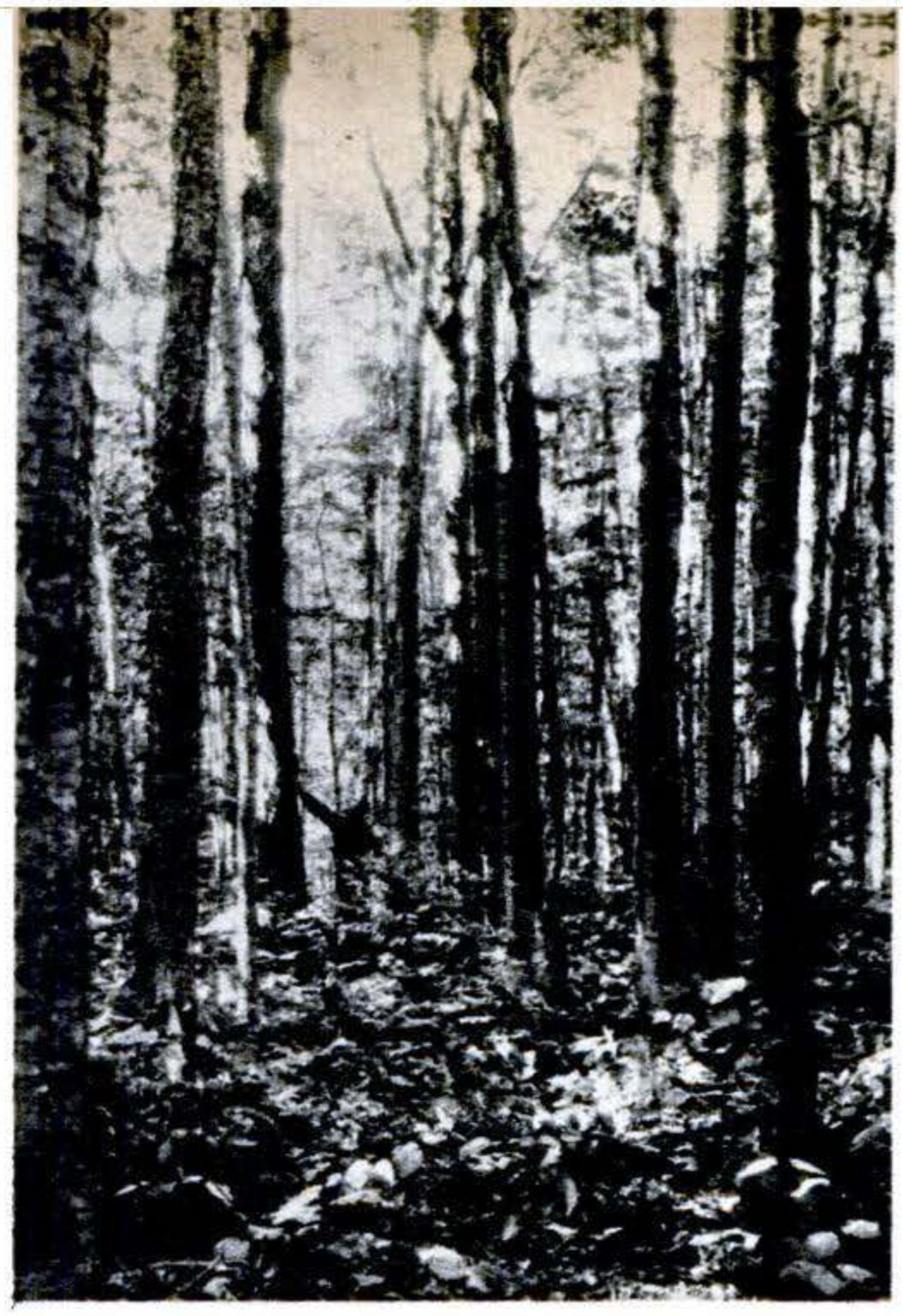
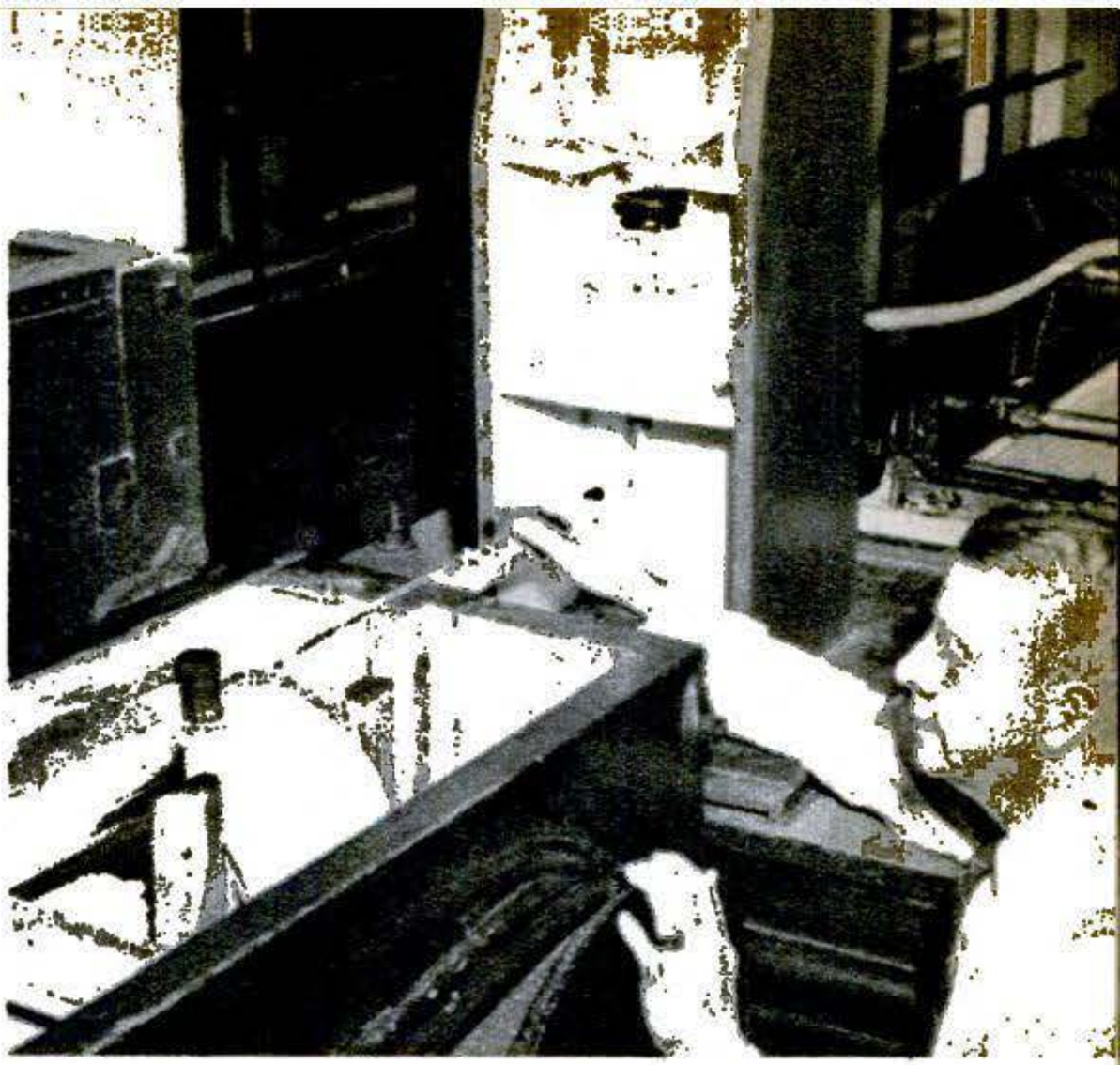


Vast stands of hardwood, like this one in Vermont, have been added to nation's supply of pulp timber by use of man-made resin to cement their short fibers into sheets of paper.



Synthetic resin, a plastic called melamine formaldehyde, is added to pulp during soaking in experimental paper mill operated by the National Bureau of Standards in Washington.

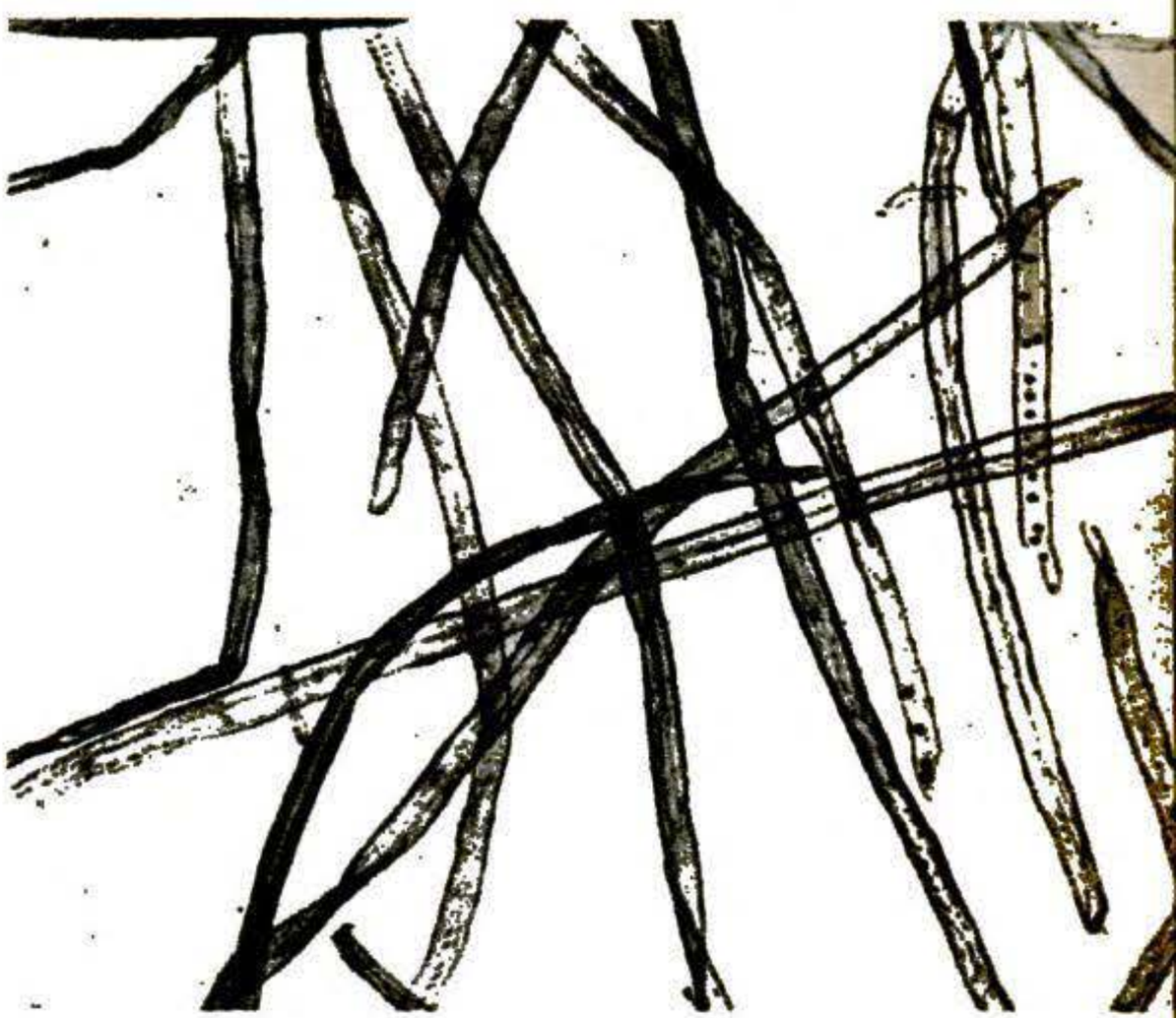
New Way To Make Paper Boosts Supply

USING a synthetic resin that's stronger than the natural glue in wood, the National Bureau of Standards has developed a way to make printing papers from short-fibered trees. What's more, the new process also makes better paper from the scarcer long-fibered varieties previously needed.

Normally, in making paper, ground-up wood pulp is soaked and beaten by machines. Beating causes the fibers to absorb water and become coated with a natural gel. This is the cement that holds them together when pressed into sheets of paper.

But beating also causes some of the most troublesome behavior of paper in printing: stretching, curling, slow absorption of oil, show-through of images.

Adding synthetic resin to the pulp during soaking not only supplies the extra-strong cement required to bind short fibers into sheets, but cuts down the injurious beating formerly needed by long-fibered pulps.



Microphotograph shows long fibers of spruce. They mat together in strong sheets with no binder other than natural gel formed by absorption of water when pulp is soaked and beaten.

Short fibers of aspen (below), formerly used only as filler with long-fibered pulp, now can be made into paper by adding resin. New process also works with maple, beech, birch, poplar.

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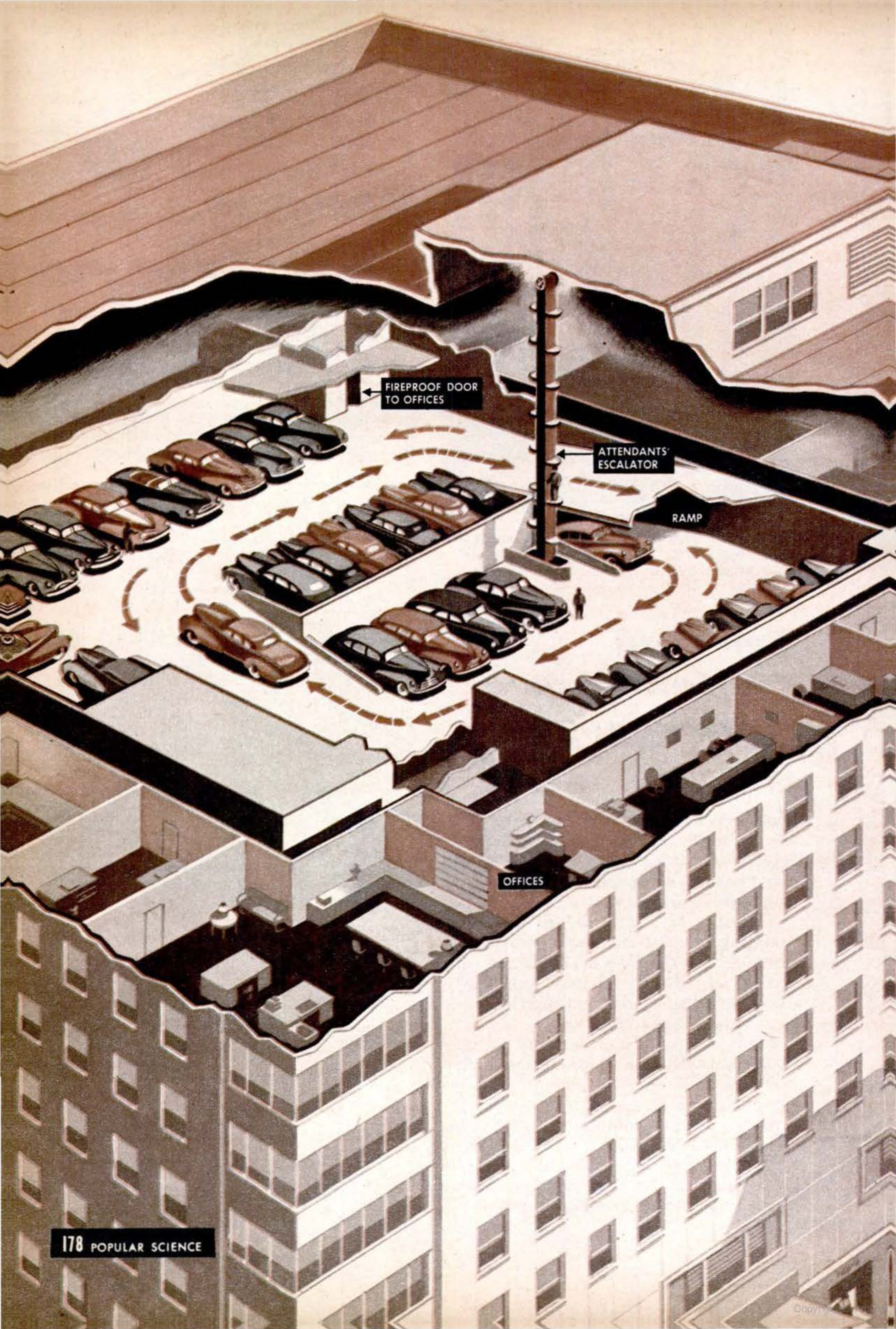

FIREPROOF DOOR TO OFFICES
ATTENDANTS' ESCALATOR
RAMP
OFFICES

New Office Is Garage, Too

Tenants in this building will be able to drive cars inside to parking space on their floor.

SOME Washington executives will soon be parking their cars next to their desks in a 10-story office building that is to be built around a parking garage. Tenants will drive right inside the building, up a ramp to their personal parking spaces, and then walk through a door to their offices.

Offices will take up only the outer shell of the new building. The entire core, separated from the offices by fire-resistant walls, is to be taken up by the parking garage. It will hold 450 cars on 25 levels, interconnected by a nine-degree, 20-foot-wide ramp in the very center. The garage will be equipped with its own ventilating system to carry off exhaust fumes. The building will have two automobile entrances, but two-way traffic will be permitted on the ramp.

Attendants supervising the parking will use a mechanized version of the firemen's brass pole—a sort of vertical escalator. A moving belt with bars for handgrips and footrests will carry them up and down between parking levels. To move from one level to another, the attendant will jump on the belt, ride as far as he wishes, then jump off.

The office-garage, designed by Leroy L. Werner for the Cafritz Construction Co., is scheduled to be completed in 1950.

How Quarried Rock Becomes A Slate Roof

One of the few pieces of mechanized equipment used in slate quarrying is the tackle that lifts the rough blocks, each weighing several tons.

Mountains near Poultney, Vt., are scored with rich veins of slate—gray to green and purplish red in color. The rock is quarried from open pits.

This heavy mallet drives wedge into slab to split it. The slab will be split again and again until the pieces are as thin as desired for roofs.

THE best homes in America are still being roofed the old-fashioned way with a natural material that defies moisture, flame, and age—slate. And slate is still being prepared in the old-fashioned way, almost entirely by hand. In quarries such as this one at Poultney, Vt., descendants of Welsh slate miners carry on their forefathers' trade, turning big hunks of the argillaceous (means "made from clay") rock into thin rectangles for roofs. Slate's ability to split evenly results from tremendous pressure exerted on it in ages past when it was buried deep in the earth.

The finished slates, split to proper thickness and cut to shape, are stacked at the quarry ready for shipment to the site of construction.

After this pneumatic drill makes holes at a few strategic points, a few sharp blows with the mallet will cause the slate block to split.

A worker selects the points for splitting slab in thin sheets with a wedge. Some finished slates measure no more than 1/16 inch in thickness.

After the rough blocks have been split, they are trucked to the machine—called a guillotine—that trims them to rectangular shape for shingles.

Guillotine trims with blade that drops on slate held over stationary knife. Man in foreground is making last split to final thickness desired.

Slate is applied on top of the roofing paper in overlapping layers, so that at least a double thickness of shingles covers roof at every point.

Typical of the handsome finish attained with slate is this home in the quarry town of Poultney. Its walls are also made of slate—thick blocks.

New 'Copter Almost Flies Itself

Blades intermesh as Kaman helicopter's twin rotors turn on shafts canted outward 13 degrees.

By Devon Francis

PS photos by W. W. Morris

AT WINDSOR LOCKS, Conn., a new kind of helicopter is being test-flown.

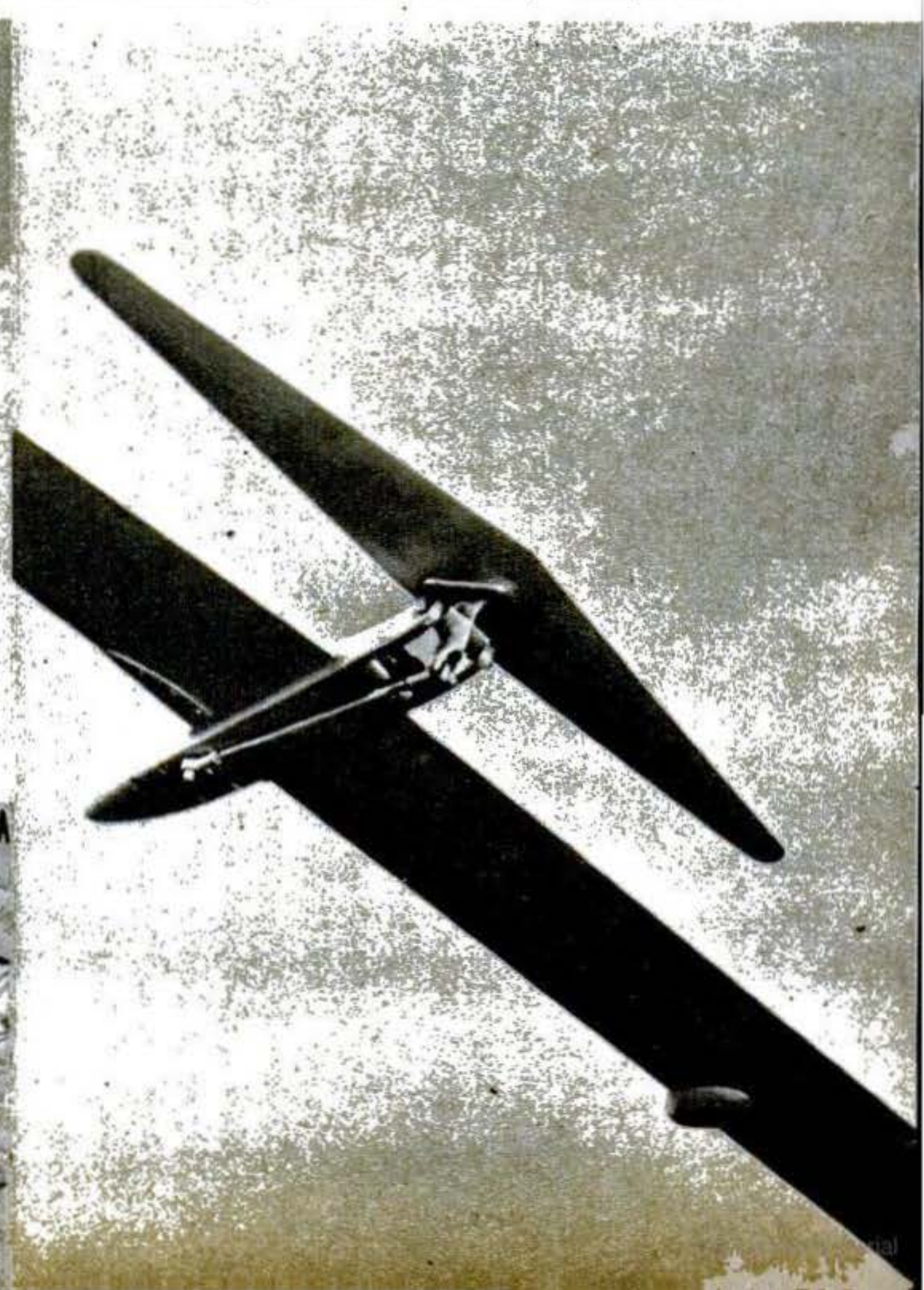
In this machine, Charles H. Kaman has introduced a fresh idea to flight on rotary wings. With one little gimmick, he eliminates much of a mess of machinery for changing the pitch of the rotor blades.

And, in eliminating machinery, he has also eliminated much of the shuddering vibration that gives the pilots of most helicopters the shakes. The Kaman 'copter can be handled with one finger. In fact, it can be flown "no hands" for short periods.

Kaman's little gimmick is a tiny tab near the end of each blade. This tab acts exactly like the control tabs on the ailerons, elevator, and rudder of a conventional airplane. In effect, it uses leverage to twist the big blade.

The best way to describe Kaman's innova-

Flexible rotor blades are made of laminated Sitka spruce to twist and bend without damage or fatigue. Key to helicopter's finger-tip control is a small flap (right below) projecting from trailing edge of each blade. This serves as a tab to twist rotating blade and vary its pitch.



Machine is highly maneuverable because stick action is transmitted directly to blade tips.

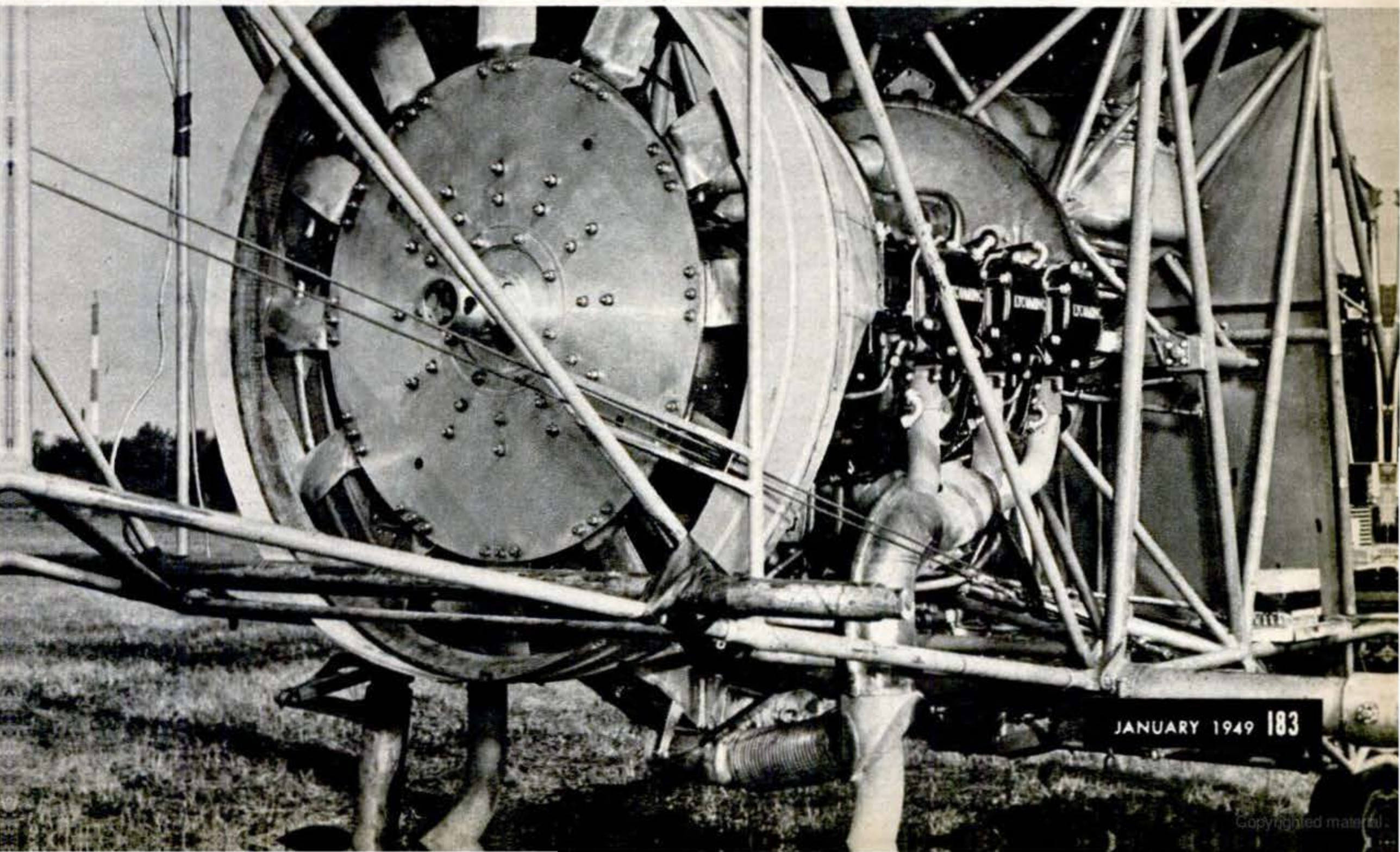
tion is to explain why all helicopter blades have to change pitch in flight.

There's, first, *collective* pitch control. This is necessary to make a helicopter go up and down. Like an airplane propeller, a helicopter blade takes a bigger bite of the air—for more lift—when it is in high pitch to go up, a smaller bite when in low pitch to go down.

But there is another kind of pitch change. This is in *cyclic* pitch. To move forward, backward, or sideways you change the pitch for only part of each rotation—decreasing it in the direction toward which you want to move, increasing it on the opposite side. You also need cyclic pitch control to keep the helicopter from rolling over in the air.

That's because a blade moving toward the line of flight in its circuit develops a lot more lift than it does when moving away from the direction the helicopter itself is going. The speed of the air past the machine in horizontal flight is added to or subtracted from the

Air-cooled, 190-hp. Lycoming engine will take 'copter, carrying pilot and two passengers, 235 miles at 75 m.p.h. on 32-gal. tank of gasoline. Mounted in reverse, engine turns 35-in. cooling fan in foreground. Helicopter's gross weight is 2,500 lb.; its operational ceiling is 11,000 ft.



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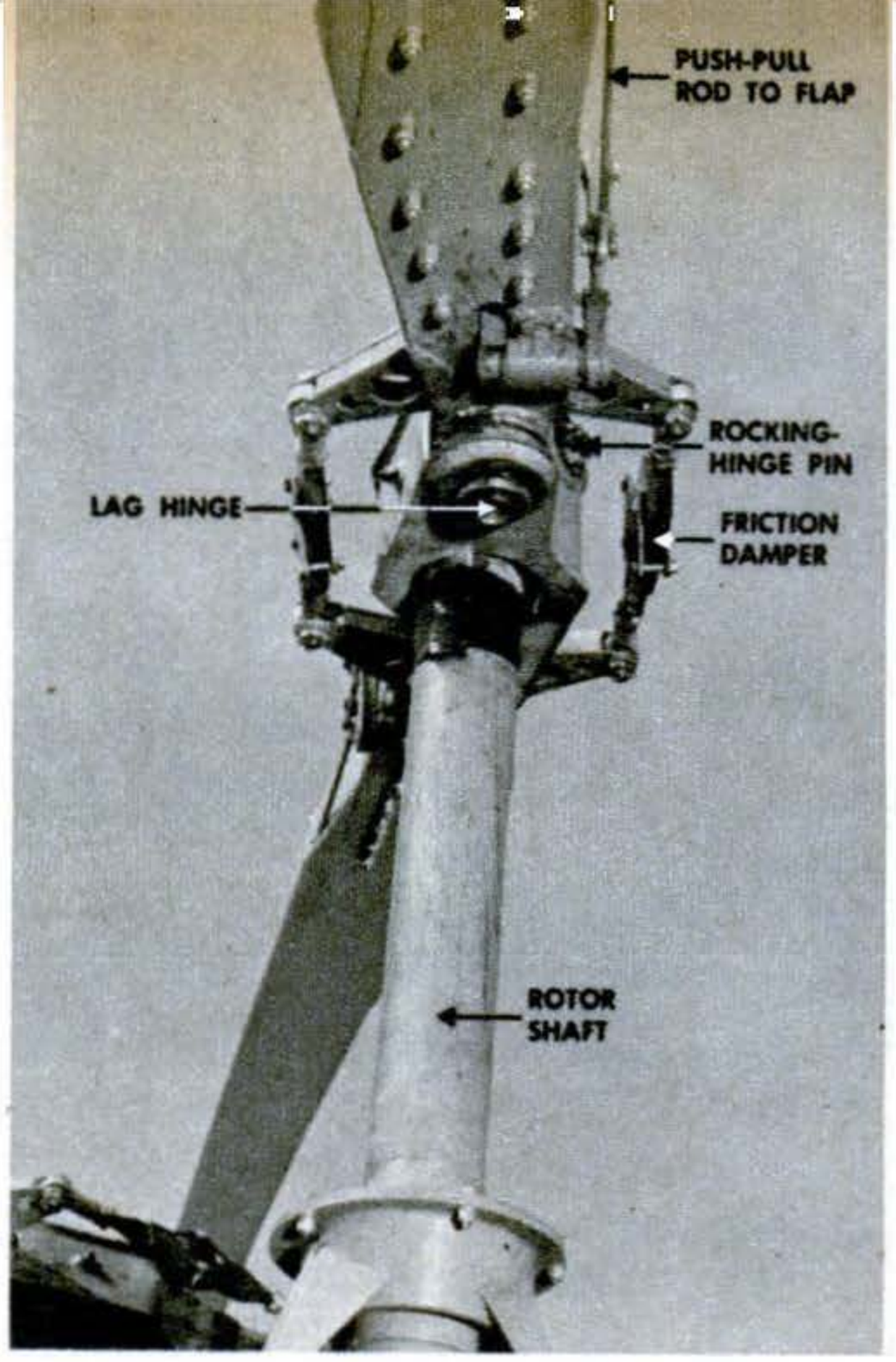
speed of the air past the blade in its own rotation. If something weren't done about equalizing the lift on the right and left sides of the 'copter, it would turn over.

Most helicopters make the necessary continuous adjustments in pitch by twisting the entire blade in its socket, just as the blade of an airplane propeller is twisted to alter its pitch. This takes a lot of machinery and considerable force. Each blade is under thousands of pounds of centrifugal pull, and it moves grudgingly.

About three and a half years ago, Kaman got another idea for equalizing the lift. He bought a piece of plank for $1.75 and went to work. Instead of twisting the whole blade in its socket, he planned to make it highly flexible and twist the wood itself near the blade tip—where most of the lift develops. When he worked that out successfully, he went on to build a helicopter.

The result was a 'copter more maneuverable than any other this writer has seen. The pilot who flew it in the demonstration I saw handled it like a baby carriage. Its vibration is low both because Kaman's blade tabs reduce the mass of machinery needed for pitch control and because his flexible blades absorb a lot of the vibration ordinarily transmitted to the control stick.



Kaman system of pitch control simplifies rotor head, cutting weight and cost. Blades rock on seesaw, swing back and forth in small arc between friction dampers, as engine power changes.

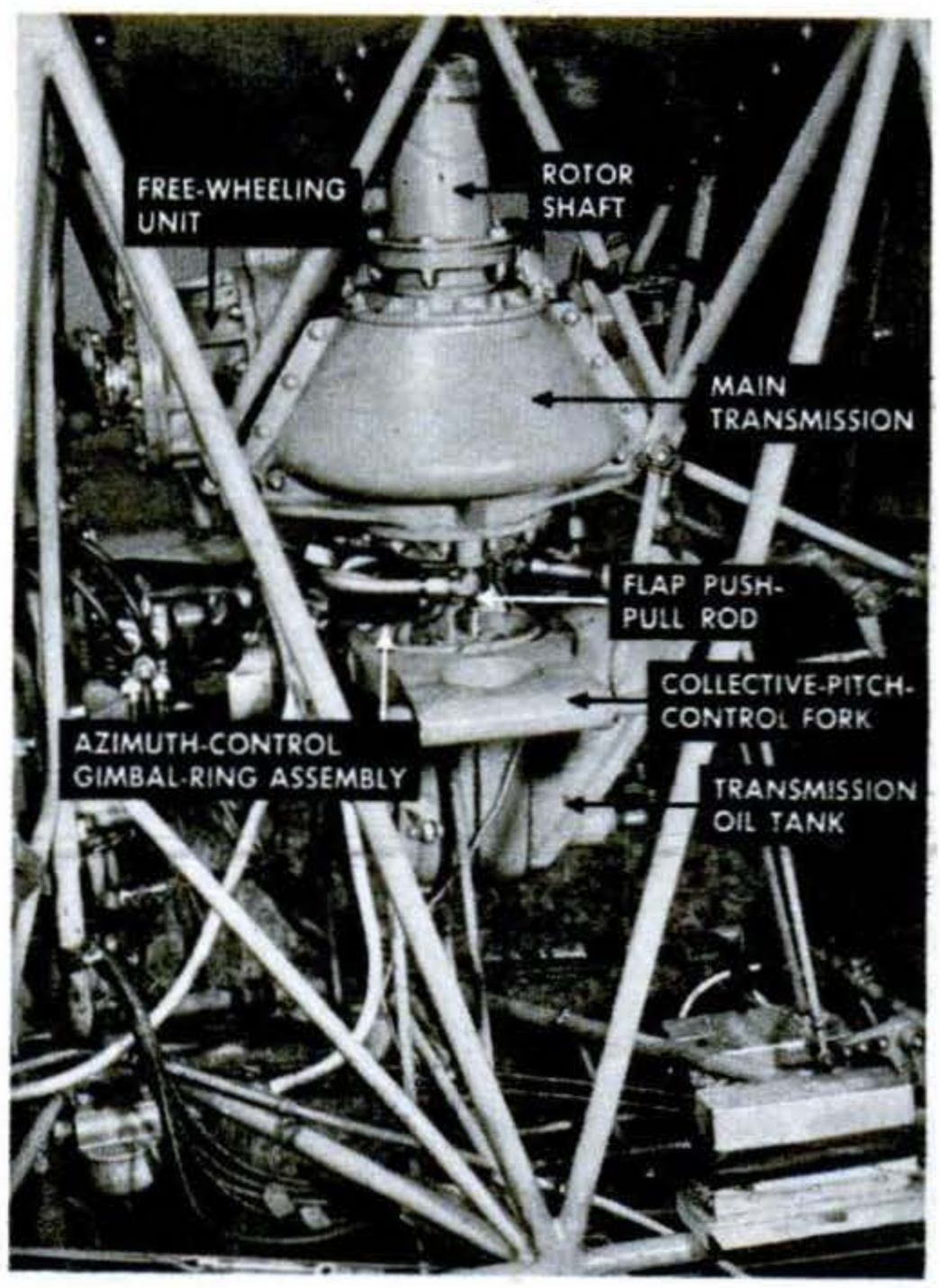
Rotors Mesh Like Eggbeater's

The Kaman Aircraft Corp.'s machine has another distinguishing characteristic: it uses two main lifting rotors of two blades each. These are set close together amidships and intermesh as they whirl. Two counter-rotating windmills are necessary to cancel out the effect of torque—in this case a tendency of the fuselage to turn in the opposite direction from the rotor.

Various other 'copters overcome this tendency by putting lifting rotors fore and aft on the fuselage, by putting them on long arms on each side, by rigging one above another on the same shaft, or by putting a little vertical rotor on the tail to fight the twist from a single main rotor. Kaman argues that the system incorporated in his helicopter is simpler than any of these.

His creation is not handsome. It looks like some of those awkward bugs that hover over scummy water on a pond. But, the Kaman people point out, their 'copter is a piece of industrial equipment – made to dust crops, patrol pipe lines, carry surveyors.

"Ever see a streamlined farm tractor?" they ask. END



Transmission is conventional, but reduced vibration eliminates need for usual shock-mounting. Engine or transmission can be pulled separately. This cuts maintenance time and cost.

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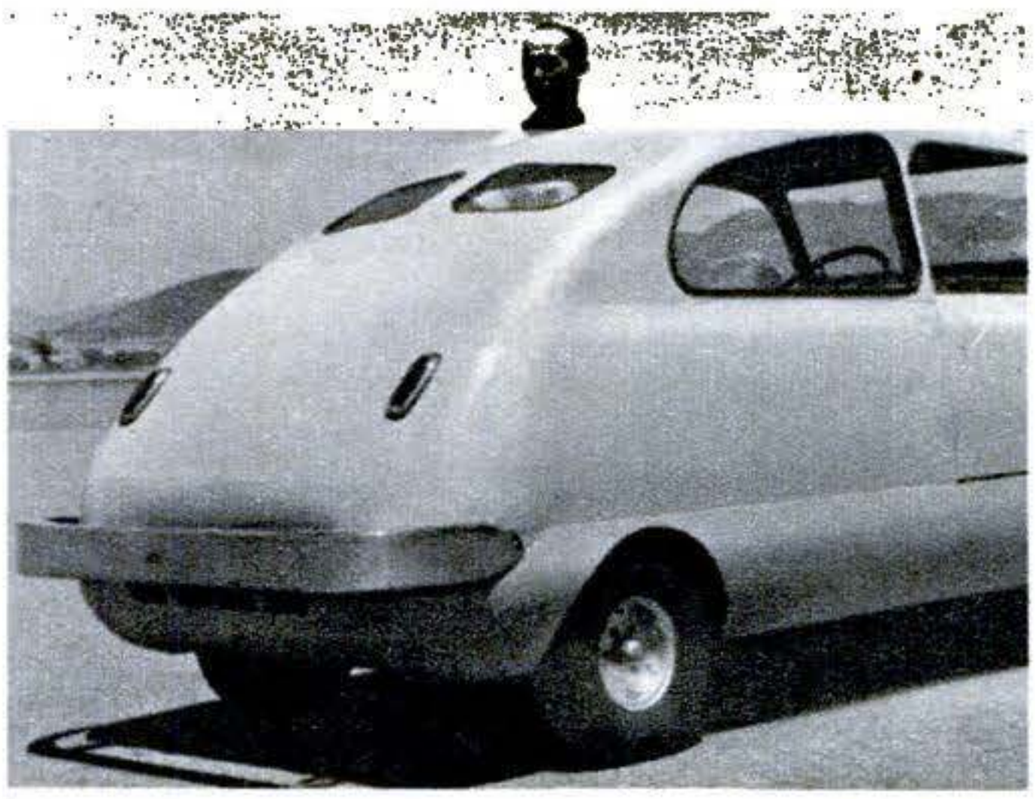
$750 Car Has Fluid Clutch

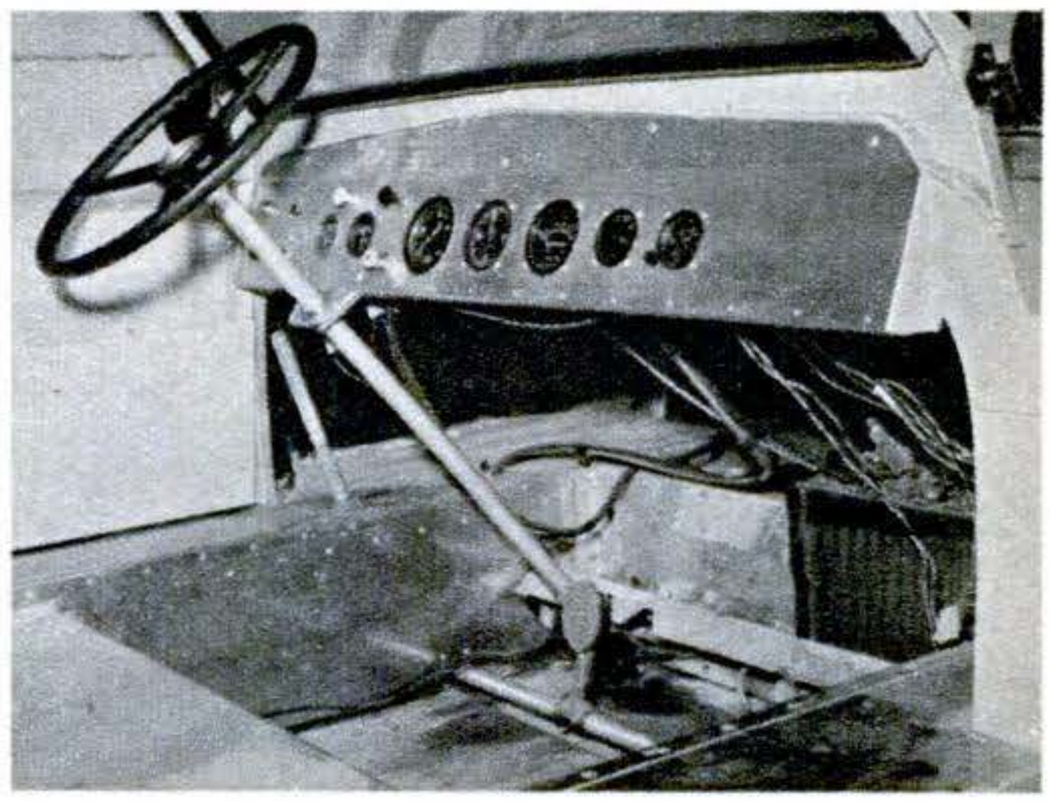
Small but not tiny, the Airway seats three in comfort. It's made mostly of aluminum and has a 10.6-hp. air-cooled two-cylinder Onan engine.

ECONOMY is emphasized in the Airway ®, a 600-lb. car intended to sell for less than $750. Designed by aeronautical engineers, the car features a no-clutch fluid drive and a 10.6-hp., air-cooled engine located in the rear. Top speed is 50 m.p.h. and the makers, Airway Motors, Inc., San Diego, Calif., claim a thrifty 50 miles to the gallon of gas.

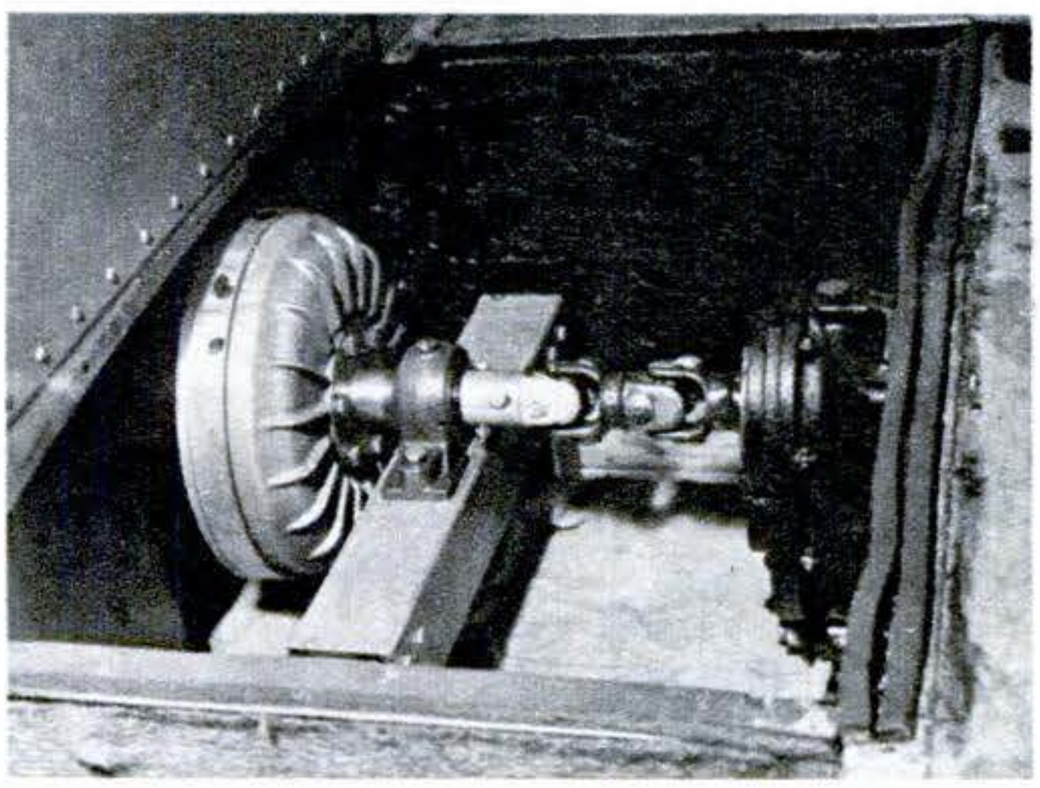
Although manual gear shifting is not normally required, a low gear for steep hills is provided. The car's light weight is due to its construction—almost entirely of aircraft aluminum—and its 120-lb. engine. The engine, easily removed for servicing, operates through a universal to a standard two-speed transmission. Approximately 100 parts, as compared to several thousand in the usual car, are incorporated in the Airway.



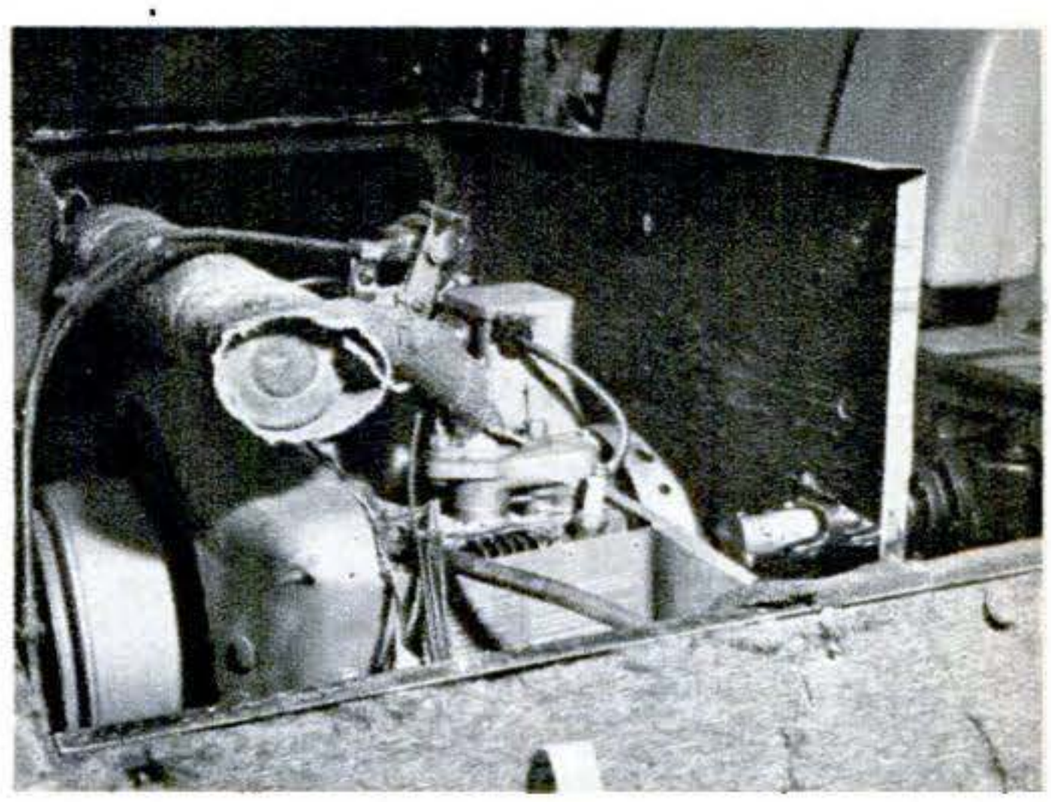
The aircraft influence is apparent in both the looks and engineering of the car, which is to be made in part at Consolidated-Vultee plant.



Instruments include oil-pressure gauge, ammeter, engine and transmission tachometers, cylinder-head and carburetor-air heat indicators.



Fluid clutch connects through a universal joint to a two-speed transmission. Sprocket on transmission drives left rear wheel by chain.



Engine of 38.8 cu. in. displacement is located on right side immediately behind seat. Air for cooling is ducted in from beneath.

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Gus Settles Some

In a cluster stood the drivers — three men and a woman. They were loudly accusing one another of causing the tangle.

Cold-Weather Blues

When frozen gas lines brought double trouble this cold morning, Gus proved that there's more than one way to get water into your gas tank.

By Martin Bunn

IT WAS just one of those things that happen from time to time. Every one picked the same morning to be late for work at the Model Garage, and they all had the same excuse—ice. Lots of ice. Every street, highway, and sidewalk for miles around was coated solid.

Gus Wilson eased his old coupe across the slick drive to the door of the shop ten minutes after the usual opening time. Stan Hicks and Greg Jones, the grease monkey, came sliding and skidding across the ice-coated highway from the bus stop.

"All the buses are way late," Stan explained.

"I didn't make it on time myself," Gus admitted with a grin, "and I'll bet we're going to have a busy day. That big drop in temperature last night turned the rain to sleet and must have made plenty of grief for our customers."

"Holy cats!" Stan exclaimed, looking at the thermometer on the door frame. "Five above."

Greg had the door rolled aside and Gus drove into the shop. "Put chains on all four wheels of the wrecker," he called to Stan. "Before we get our coats off the telephone's going to start ringing and someone'll be hollering for help."

But the first call wasn't by phone. It arrived personally and noisily. Gus was slipping into his coveralls when a raucous chorus of horn blasts sounded outside the shop. Gus told Greg to see what all the noise was about.

"There's a lot of cars out there," Greg reported a minute later, "and they're all fighting."

"This I gotta see," grinned Gus, starting for the door. "Cars fighting with each other."

"I mean," Greg amended, "the cars are all tangled up and the people are fighting."

On the ice-glazed driveway, at divergent angles but linked together by hooked bumpers, stood four cars. In a little cluster stood the drivers—three men and a woman. They were pointing and loudly accusing one another of causing the tangle. One of them was the buxom and talkative Mrs. Miller. Another was Silas Barnstable, the town's most active tightwad. He actually works at it. The other two Gus didn't know.

"What goes on?" Gus demanded, shouting to make himself heard.

The four suddenly stopped arguing and turned to look at Gus. Silas was first to take advantage of the moment's silence.

"It's her fault," he yelped, jabbing a skinny forefinger at Mrs. Miller. "Joe Dunphy, here," he indicated a droopy-mustached individual, "was pushin' my car into your shop and she cut in ahead of me."

"I did not!" snapped Mrs. Miller.

"You did too," Silas went on. "And you busted my bumper. I'll stand you a suit in court, derned if I won't."

"*Mr.* Barnstable!" Mrs. Miller drew herself up, her voice dripping ladylike scorn. "How *can* you make such a ridiculous statement? I'm the one who should be suing. I was pushing my brother-in-law's car—oh, Mr. Wilson, you don't know my brother-in-law, George Trotter. George is married to my sister, Amanda—you remember her. She visited me three summers ago and while she was here you worked on her differential, or something. They live in Akron, Ohio, and they just came here for a visit and—now where was I?"

George looked as if he wished he had stayed in Akron.

"You were just about to sue Silas," Gus

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told her, "but before we get this case all the way to the Supreme Court, let's get in out of the cold."

Stan brought a pail of sand and scattered it over the slippery driveway. Then he helped Gus and the three men untangle the snarl of bumpers.

"No damage other than a scratch or two," Gus remarked. "Seems to me the courts won't get any business out of this after all."

"It's lucky for her," Silas grumbled, carefully examining the bumper of his old car.

"Now let's see," Gus said. "Mrs. Miller was pushing Mr. Trotter's car, and Mr. Dunphy was pushing Mr. Barnstable's. . . . All right, Mrs. Miller, ladies first."

Mrs. Miller and Trotter managed to maneuver his car into the shop. Joe Dunphy, obviously happy to be rid of the whole business, pushed Barnstable's old bus into the garage, backed out, and drove on his way. Stan shoved the door closed after him.

Gus backed up against a radiator and fished around in his pockets for his pipe and tobacco. "Well," he asked, "what seems to be the trouble?"

"I been robbed, that's what the matter is," Silas snarled.

"What, again?" Gus asked in mock surprise.

"You're derned right. Robbed," Silas said.

"You're the most robbed man I ever heard of," Gus added. "Who did what to you this time?"

"Some crook sold me gasoline with water in it," Silas howled, "and now my gas line's frozen. It's a sin and a shame the way a man gets cheated left and right these days. I'll sue 'em in every court of the land, even if I do have to pay a lawyer."

"You're sure bound to sue somebody today," Gus grinned. He knows that before Silas will buy even a gallon of gas, he shops around all the cut-rate pumps to see which one is a fraction of a penny cheaper. "You can't expect to get decent fuel for what you pay," Gus told him, "but I doubt if even the stuff you buy is actually watered. And what makes you think your fuel line is frozen, anyway?"

"Couldn't be anything else," Silas said. "The motor wouldn't start this morning—not even after I poured hot water over the carburetor. There's plenty gas in the tank but when I unhooked the fuel line to the carburetor there wasn't any a-tall."

"Do you keep this car in a garage?"

"Outdoors," Silas answered. "Naturally I ain't gonna pay the outrageous prices they ask for garages these days."

"Naturally," agreed Gus.

"Now look here," said Silas. "I'm in a hurry—a big hurry. There's a sale of overcoats down in the city and I want to get there before all the good ones are gone."

"Keep your shirt—or coat—on," Gus told him. "I'll look over your car in a few minutes." Mumbling to himself, Silas retired to a warm corner.

Trotter spoke up: "I guess my trouble's the same as his—frozen gas line. I'm a salesman. I make a lot of short trips and then leave my car standing while I see customers. Whenever it gets good and cold I have trouble. When I come out after making a call, sometimes I can't start the motor. And if it does start, it runs badly and pops back through the carburetor."

"Ever have it worked on for this trouble?" Gus asked.

"Yeah, I've had it in several shops. They all found the fuel line frozen up but none of 'em could find where the water came from."

"How about the gas?" Gus asked.

"Can't be that," Trotter answered. "I always buy the best."

"When did you find it frozen this time?"

"Early this morning," Trotter said, "I ran down to the railroad station to pick up a bag. My car had been in Gracie's—Mrs. Miller's—heated garage overnight. The motor started all right then. When I got back from the station I left the car outside while I ate breakfast. When I came out it ran for a moment and then quit. It wouldn't start. Gracie told me about you and pushed me over here."

"Need your car today?" Gus asked him.

"Well, I ought to make a few calls."

"I'll drive you," Mrs. Miller offered. "We'll have fun."

Trotter gave her a look, and Gus, thinking about the icy streets and Mrs. Miller's driving, could almost see him shudder.

"I'll probably have your car ready by this afternoon," Gus told Trotter.

As Trotter left the shop with Mrs. Miller, Silas came out of his corner.

"Hey. . . . How about my car?" he grumbled. "I told you I was in a hurry."

Gus didn't answer him. He got into Barnstable's car and stepped on the starter button. The starter whirred but the engine didn't fire. Gus got out and loosened the drain plug in the bottom of the fuel tank. He sniffed the liquid that dripped onto his hand.

"There's water in your gas, all right," Gus

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Gus turned the stream of water on the gas tank for half a minute. Then he unscrewed the cap.

said. He disconnected the line from the fuel pump to the carburetor and found it dry. Then he took the fuel pump off the car. In the trap there was water and ice. Gus told Stan to clean and wash the pump in gasoline.

"I could have done that myself," Silas grouched.

"Why didn't you?" Gus asked him.

Silas ignored the question and went on: "What I want to know is how the water gets in the tank if, as you say, those crooks ain't selling me watered gas."

Gun unscrewed the cap of the gas tank and studied it carefully for a couple of minutes. He took a piece of clean rag from his workbench drawer and wadded it tightly into the filler hole of the tank. Then he screwed the cap in place.

"Greg," he called, "hook up the hose and bring it over here." Greg handed the nozzle to Gus, who turned the stream of water on the gas tank. After half a minute he shut off the water, unscrewed the cap, and took out the rag. It was soaking wet.

Gus laughed and held the cap out to Silas. "How much did you pay for this? A dime?"

"A dime?" Silas cackled. "No, sir, I got it at a cut-rate place for a nickel."

"Why, you did even better on that than I thought," Gus said.

"Just because I got a little laid aside, I ain't gonna waste my money paying you fellers fancy prices for these things."

"No, I guess not," said Gus. "You'd rather waste it buying junk that gets you in trouble. You bought this leaky cap for a nickel. It let water into your tank every time a hard rain came along. And then the water froze every time the weather turned cold. A good fuel cap would have cost you 40 cents. Now you've got to buy another cap and you've got to pay me a buck for this trouble-shooting job. Figure it out yourself."

Silas figured it out quickly and his face turned a bright red. "You gimme that old cap," he said. "I'll get my nickel back from that crook. If he don't give me it, I'll sue."

"Here we go again," Gus shrugged.

After Silas had driven out of the shop, Gus put Stan to work checking the tank of Trotter's car, while he himself took off the fuel pump. It not only had water in it, but also a surprising amount of dirt and sediment. Gus cleaned it and put it back on. He was just drawing up the bolts when Stan came up.

"Nothing wrong with *his* gas cap," the young mechanic reported. "It's got a good gasket and clamps on tight. But there's water in the tank all right, and it's dirty as blazes too. I drained out the water and got a handful of mud with it. You think somebody—kids maybe—put dirt in?"

"Could be," said Gus thoughtfully. "The pump had more than its share too, so we better blow out the line. That's probably where the ice was, and we'll clear out the dirt too. . . ."

It was done, and the first churning of the starter promptly drew clean gas into the pump bowl, whereupon the engine took off lustily.

"That does it, boss," Stan yelled. "Want me to park it outside?"

Gus was about to say it might as well stand in the warm shop, which wasn't crowded. But an uneasy feeling refused to disappear.

"We fixed it," he growled at last, "but we didn't *solve* it. . . . How did the water and dirt get in?"

"Gosh, I dunno," said Stan helplessly.

"Nor do I, but I'm going to find out."

Gus walked around the car, flipped open the fender door over the filler cap, and thrust a trouble light close. After a moment he got under the car and peered up at the same spot.

"Okay, Stan," he said on emerging. "Get under there now and finish the job."

Stan, much mystified, peered into the same place. When he got up, his face was red.

"Guess I did it again," he mumbled. "But who ever saw the hose coupling between the filler spout and the tank pull loose like that?"

"We did," Gus retorted, cheerful once more. "Maybe the clamp wasn't pulled up tight at the factory. Anyway, the wheel slung dirt or water up into the fender and it funneled down into the loose hose neck. But as you said, who'd think of that?"

"Only you, boss, only you," responded Stan. END

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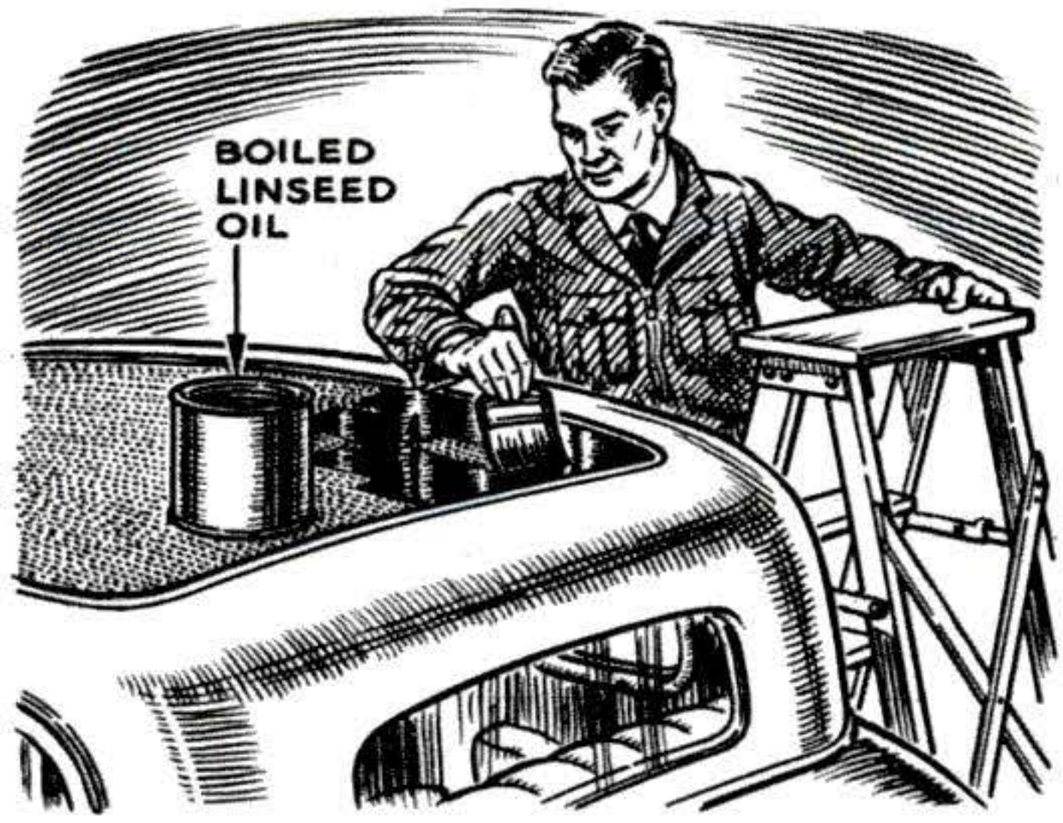
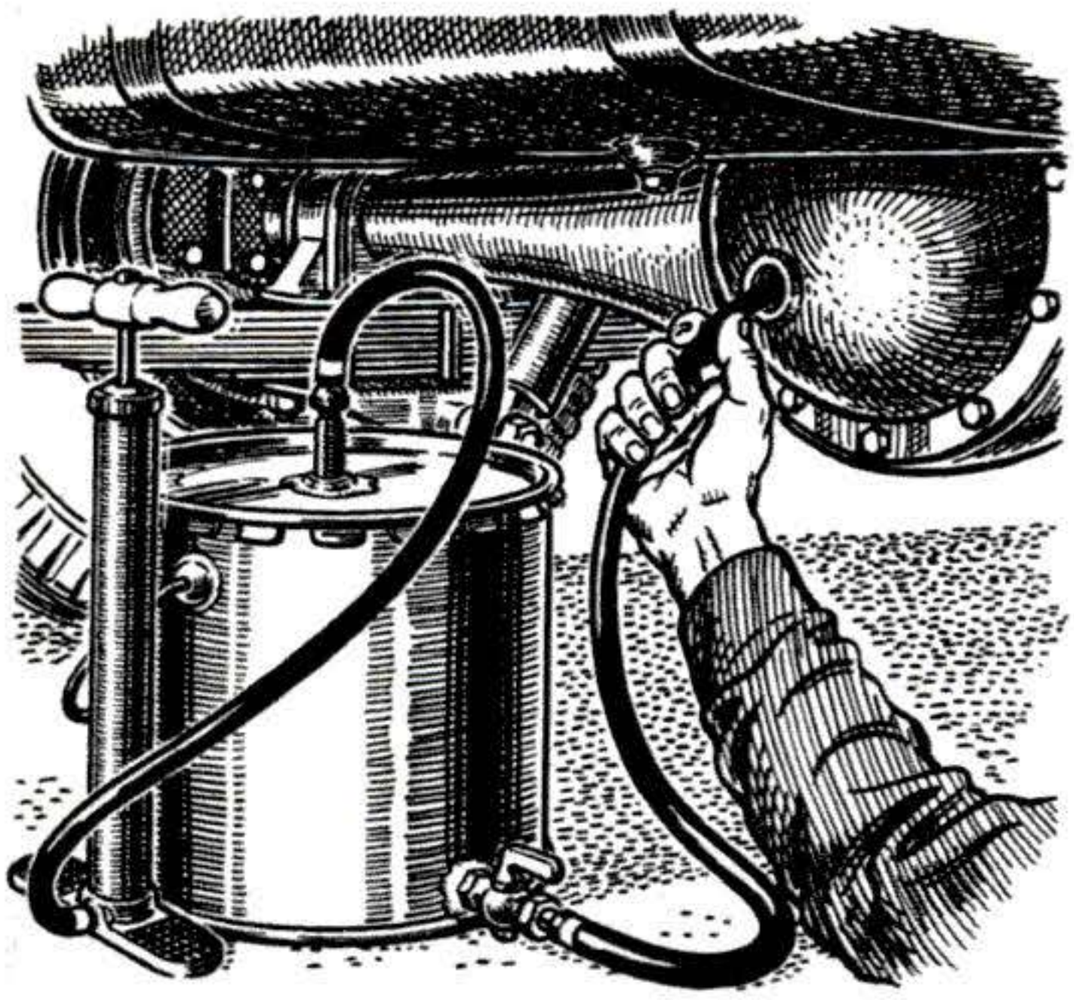
Hints from the Model Garage

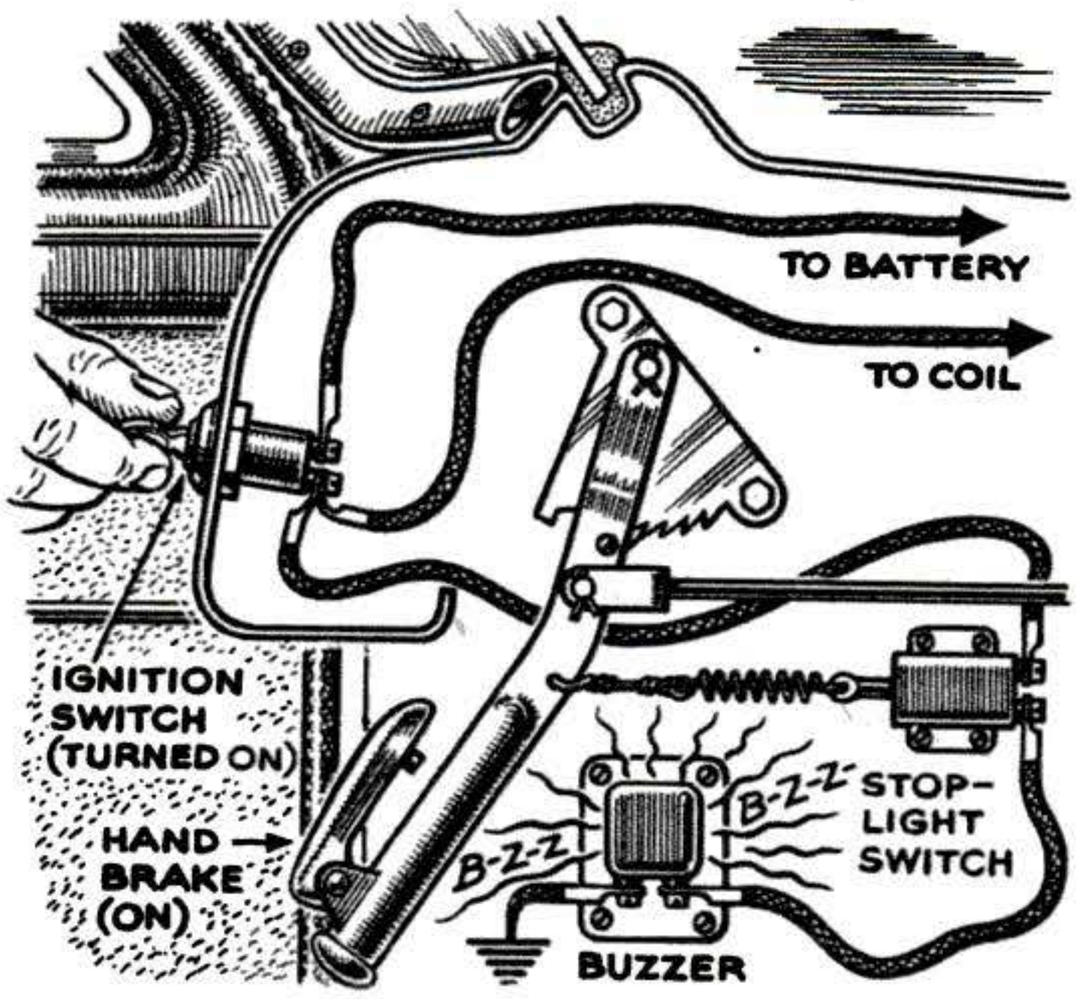
Shaving Cream Removes Grease. I carry a tube of brushless shaving cream in the glove compartment and find that it is fine for cleaning grease from my hands after a tire change or minor engine adjustment. The cream doesn't require water, and comes off with the dirt as you wipe your hands.—*Donald P. Greiner, Dundee, Fla.*



Linseed Oil Dresses Fabric Top. I have found that a good dressing for fabric tops is boiled (not raw) linseed oil. It even seals small leaks in the top, and does not crack because it is flexible. However, it requires considerable time to dry. Any paint store has it, but be sure it is boiled linseed oil.—*G. E. Boyd, Youngstown, Ohio.*



Can Makes Pressure Filler. A 2- or 5-gal. can, with a tire valve soldered in the top and a petcock soldered in the side near the bottom, makes a pressure filler for auto differentials and transmissions. Attach a flexible hose to the petcock and put a few pounds of air through the valve with a hand pump or air line and the filler is ready for use. The same idea works on a 55-gal. drum for dispensing bulk liquids.



Buzzer Warns Hand Brake Is On. After catching my wife driving with the hand brake on for the third time, I devised this simple warning gadget that is similar to those found on newer cars. I connected a doorbell buzzer through a stoplight switch to the ignition switch, as shown in the drawing. Turning the key sounds the buzzer until the brake lever is released. The buzzer is under the dash.—*W. M. Dierks, Chicago.*

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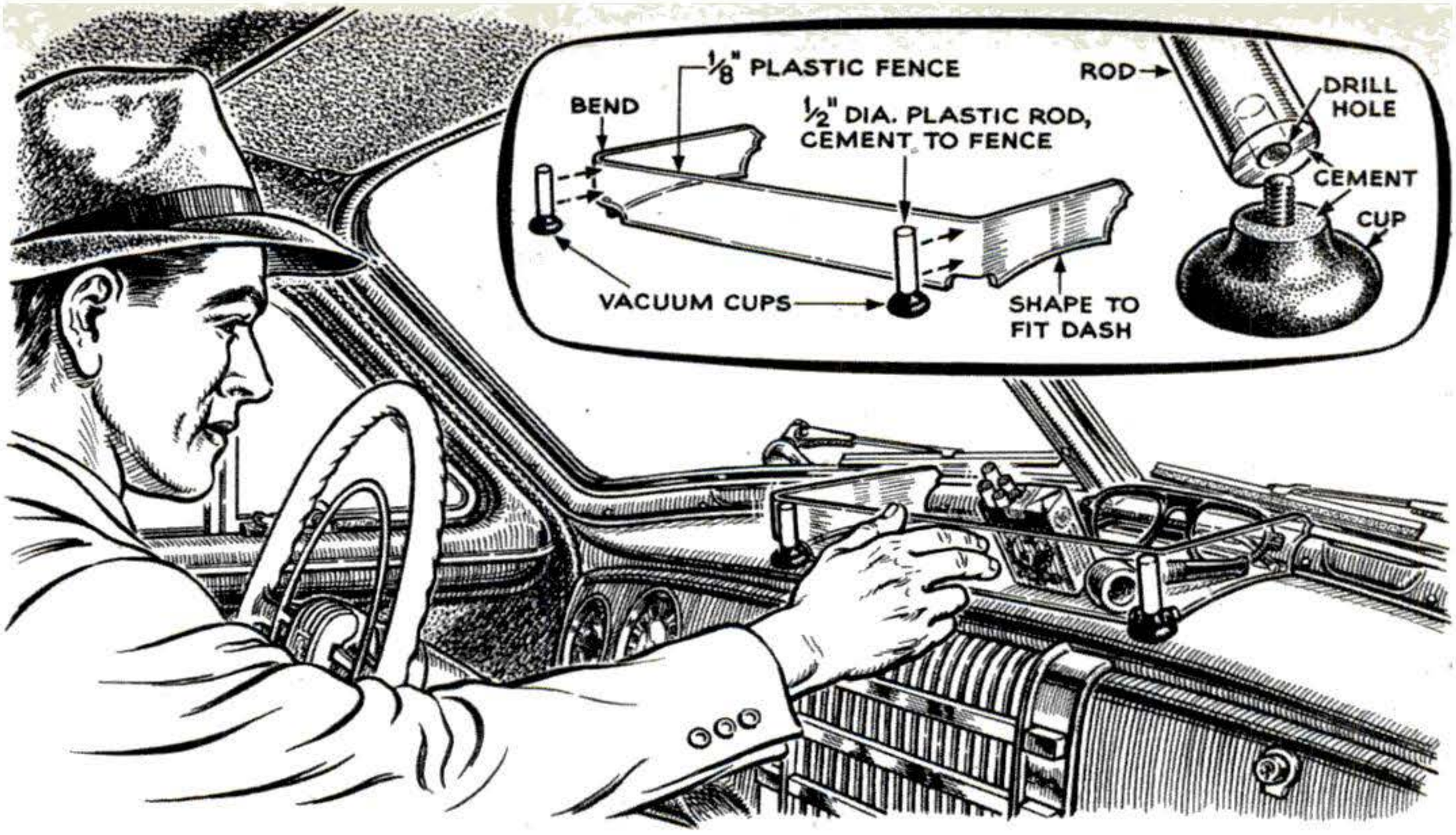
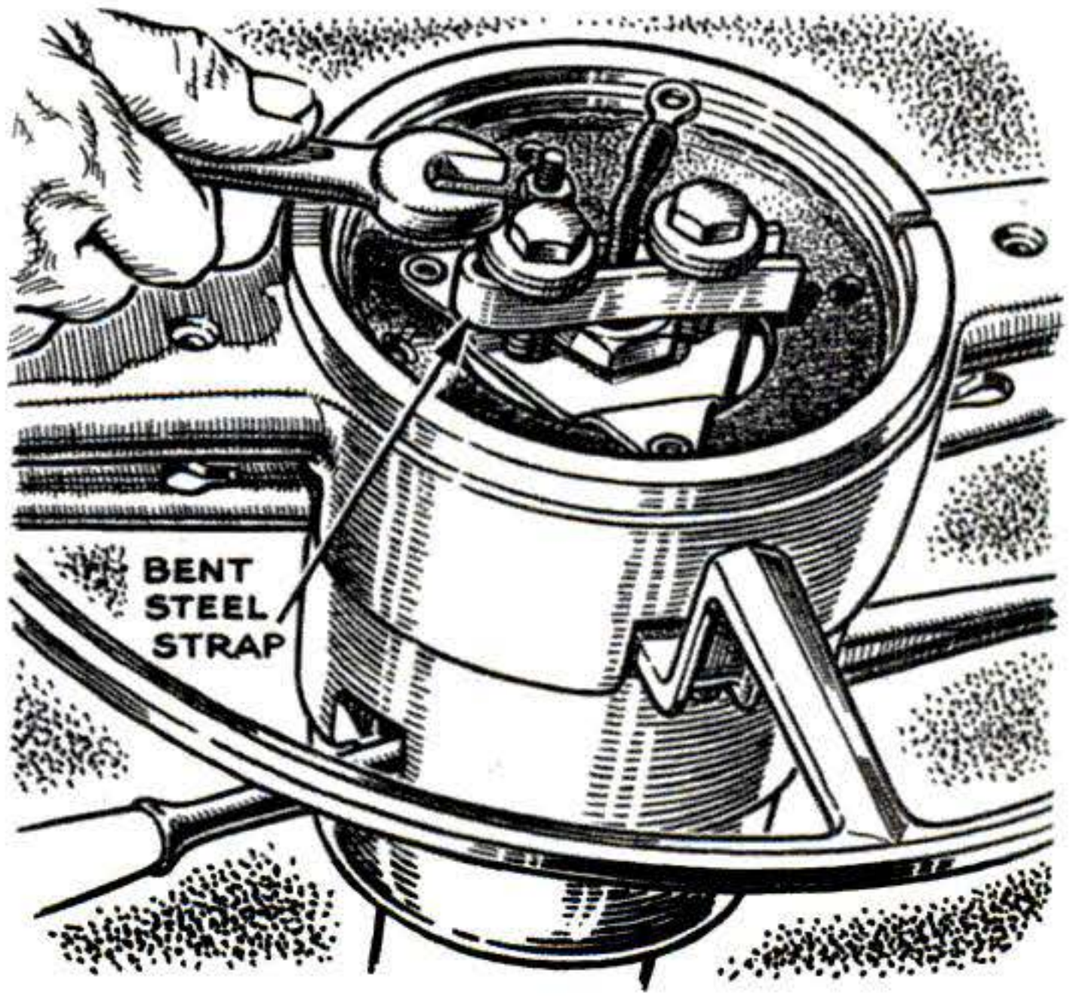


Dashboard Fence of Plastic. A strip of ⅛" plastic, bent and cemented to two posts, forms a dashboard fence that will hold a lot of those miscellaneous items you frequently need while driving. Small vacuum cups cemented and threaded to the rods will hold the fence but will not scratch the finish. Use ½" diameter rods for the posts. Shape the sidepieces to the curve of the dash, either by cutting or by molding the hot plastic against the metal. Cigarettes, matches, pencils, and other items are kept in easy reach.

Hook Aids in Attaching Chains. Putting on strap-on chains—sometimes called mud hooks—usually is a messy and difficult job. To save my fingers and time, I use a stiff piece of wire bent to an L-shape. Most wheels have a rather small opening through which the webbed strap must pass. Run the hook through the opening and use it to pull the strap through.—*John Wright, Middleboro, Mass.*



Steering Wheel Puller. Removing the steering wheel of a Frazer without damaging the wire to the horn button was a problem until I hit on the simple puller illustrated here. It is a piece of ⅛" by ½" steel strap bent to a U-shape. Two bolts, supported by washers, were used to pull the wheel. Of course, the nut on the steering post was loosened, but not removed, to provide a bearing surface for the U-bracket.

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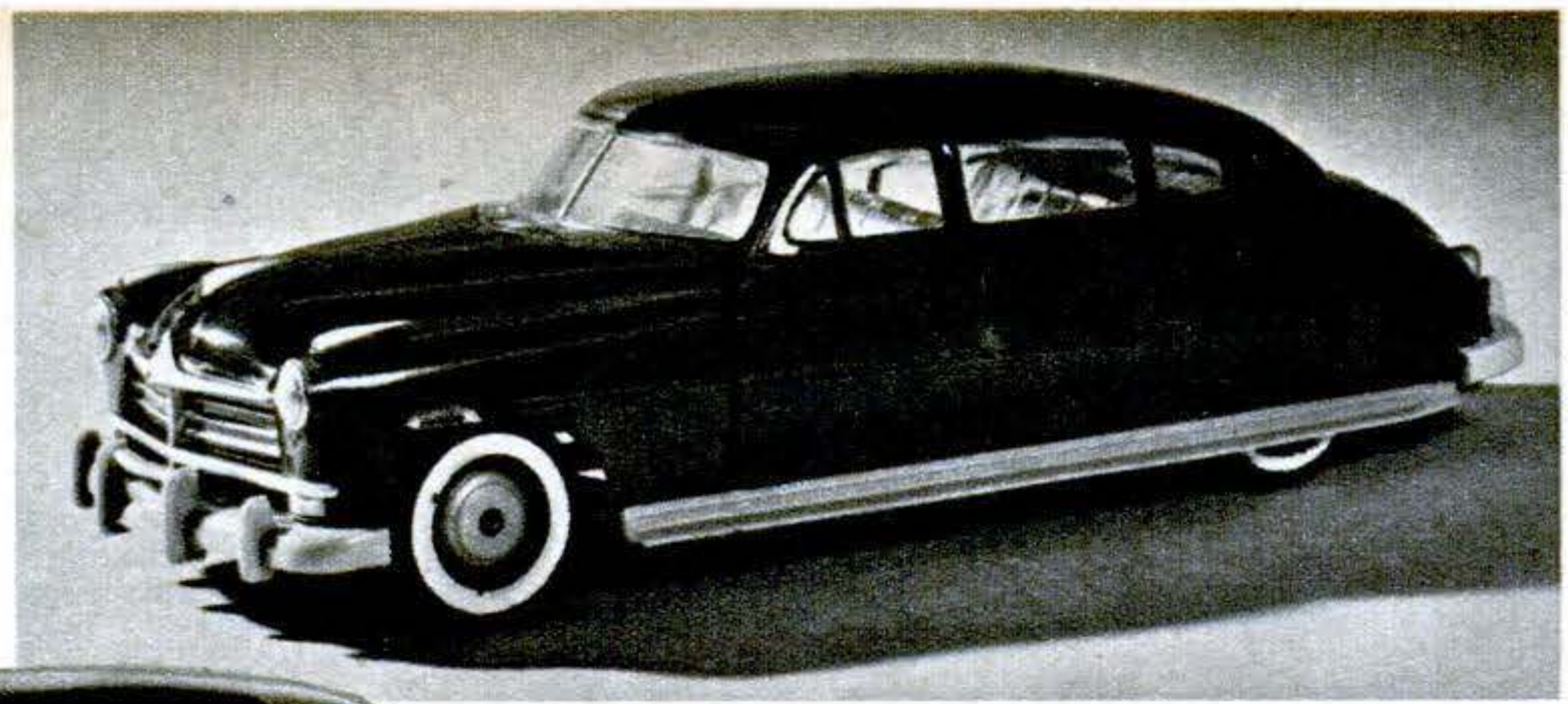
Can you tell them apart? One of these photos shows the Hudson Commodore Eight ®, while the other is the scale model that the Hudson Motor Car Co. is turning out to demonstrate the "step-down" principle.

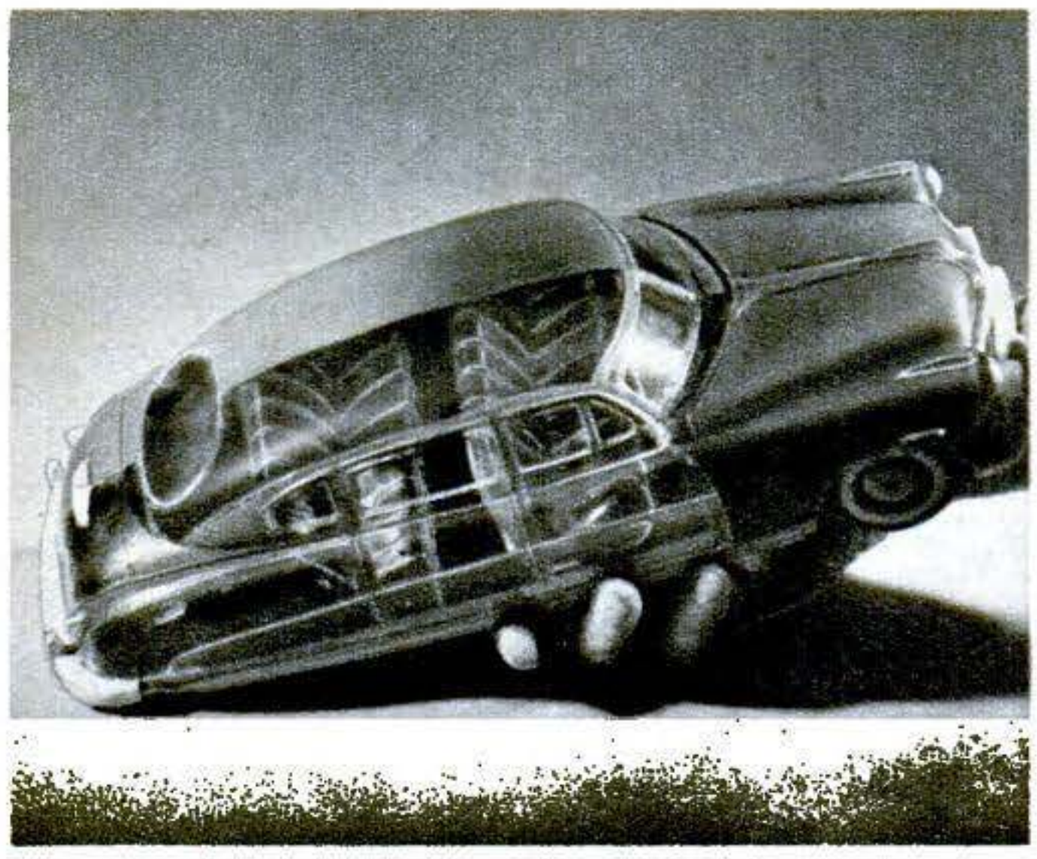


Major talking point for Hudson this year is that you step down, not up, as you get in; and the plastic models are intended to dramatize this point. Proportions of the model, above, faithfully follow those of the real sedan pictured at the left.

Model Cars Built on Production Line

THEY roll off the assembly line at the rate of one a minute—miniature cars that faithfully represent the new Hudson.

When the company decided to turn out scale models as a promotion stunt, the engineering department called in plastic specialists. They scaled down the blueprints of the big car and designed molding dies for the model. The dies alone cost $35,000 and took four months to make. Then a small assembly plant was set up. The hood, front fenders, and grille can be detached from the main unit, the body and frame, to demonstrate construction features of the new Hudson. One side of the plastic model is left transparent; the other is painted.



Here's the model. Half of it is transparent to demonstrate Hudson's Monobilt ® body and frame, which is outlined in red plastic.

Nearing the end of the production line, the major parts of the models are cemented together. Final step is inspection and packaging.

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Mechanics and Handicraft

REG. U. S. PAT. OFF.

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Be Your Own Blacksmith PAGE 206

Overhauling Old Clocks PAGE 212

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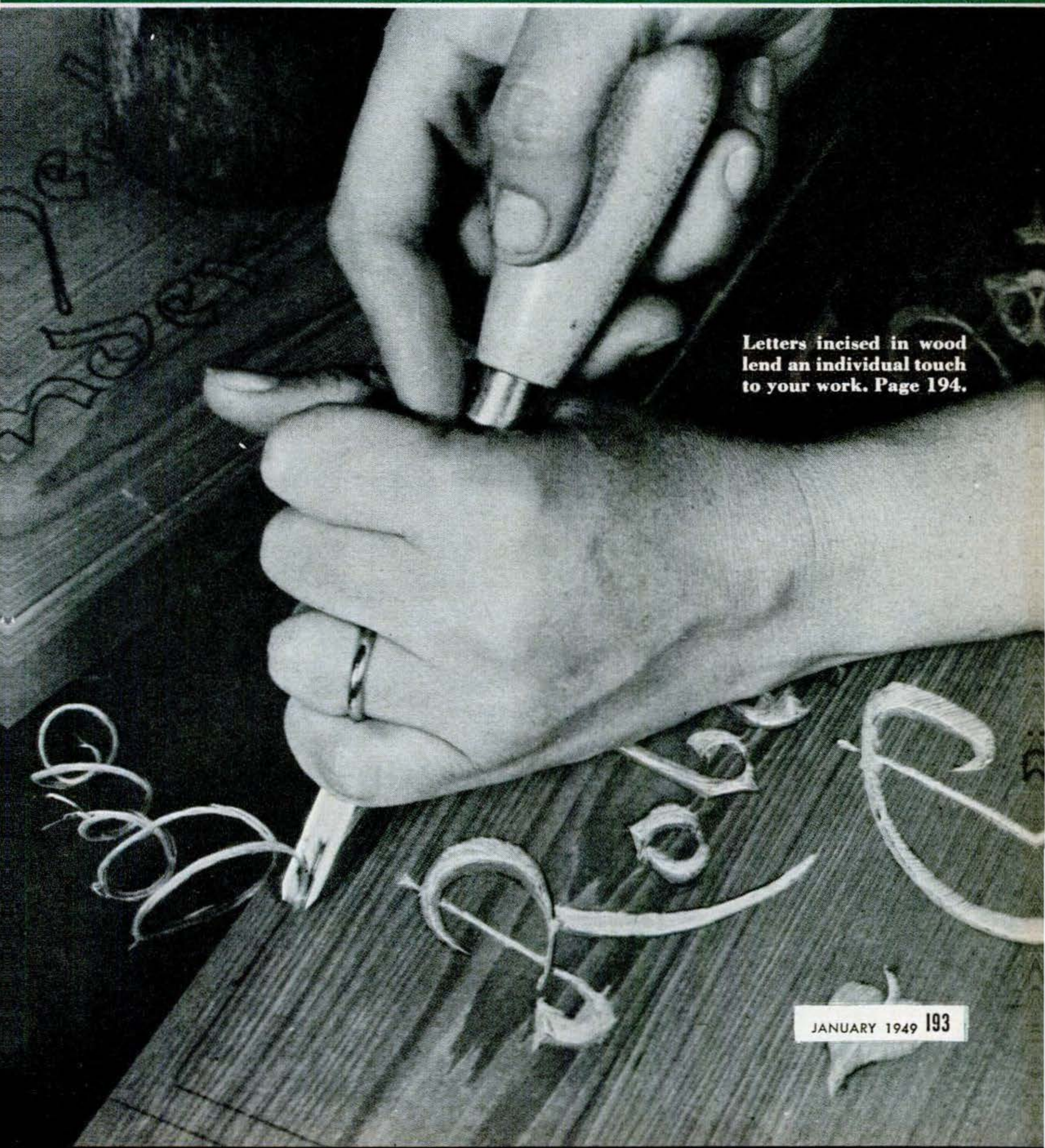
Making Tenon Joints by Hand PAGE 248

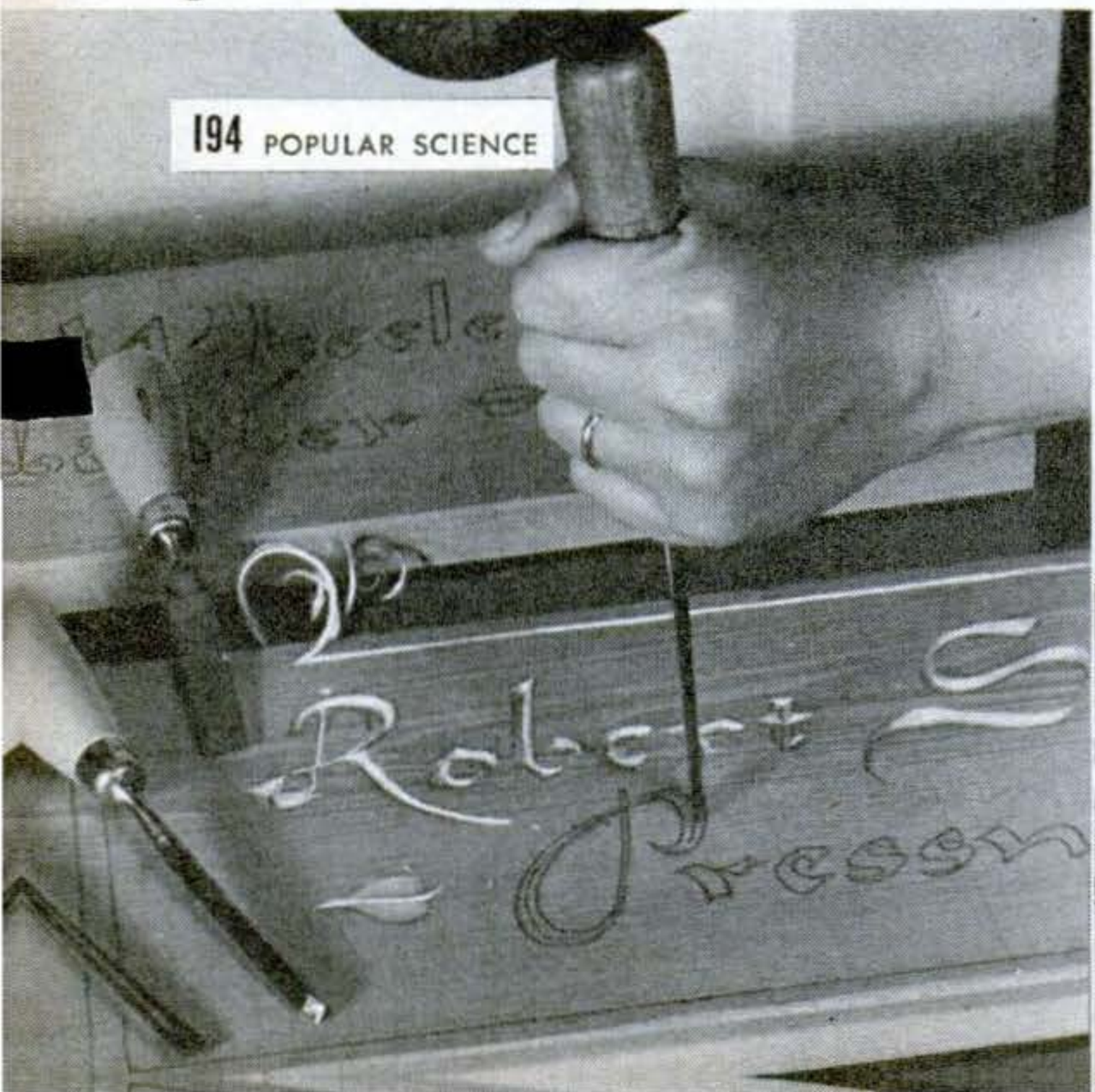


Letters incised in wood lend an individual touch to your work. Page 194.

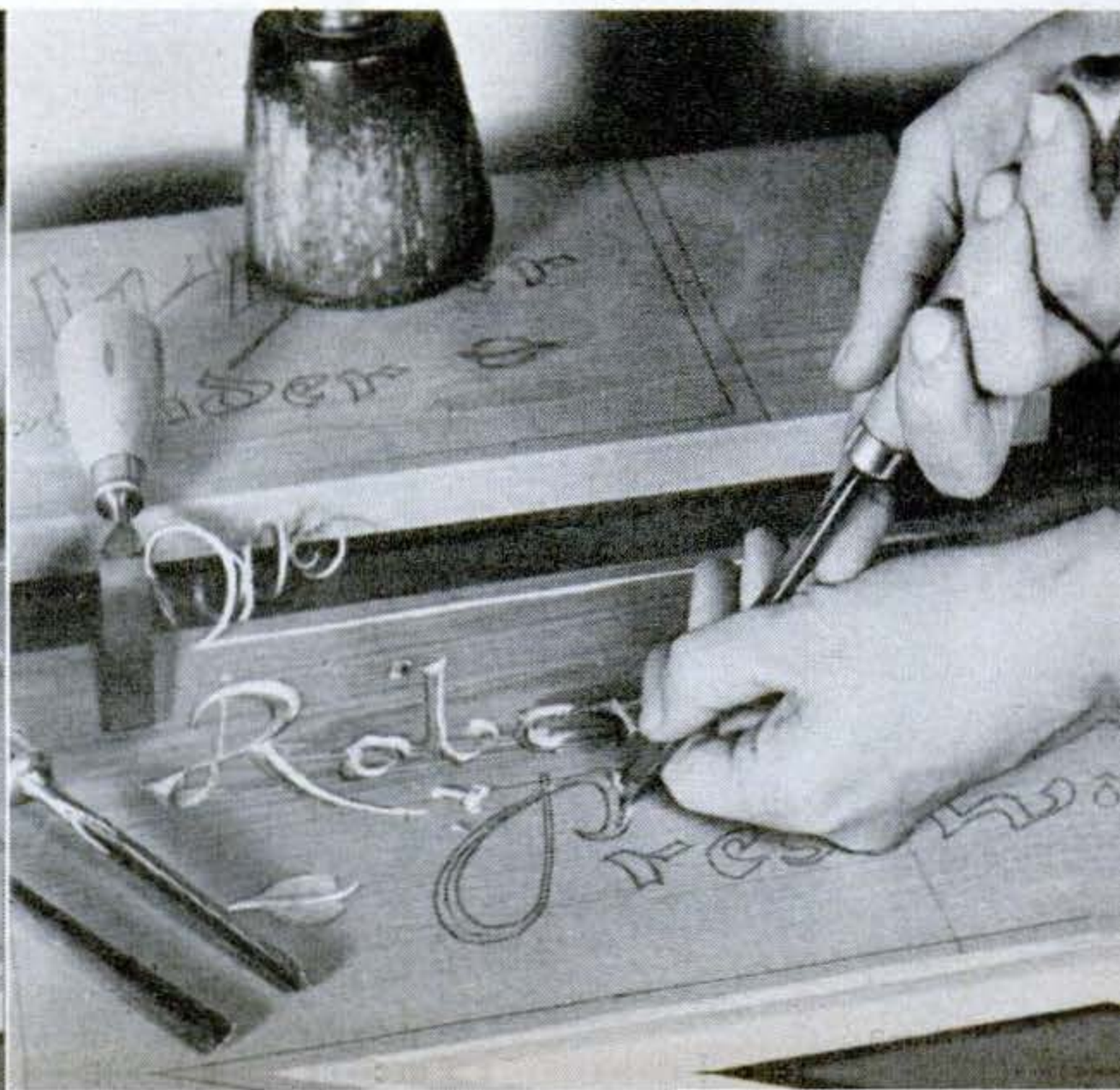
Simple tools were used to carve the lettering on this redwood chest. Type face is Hadriano.

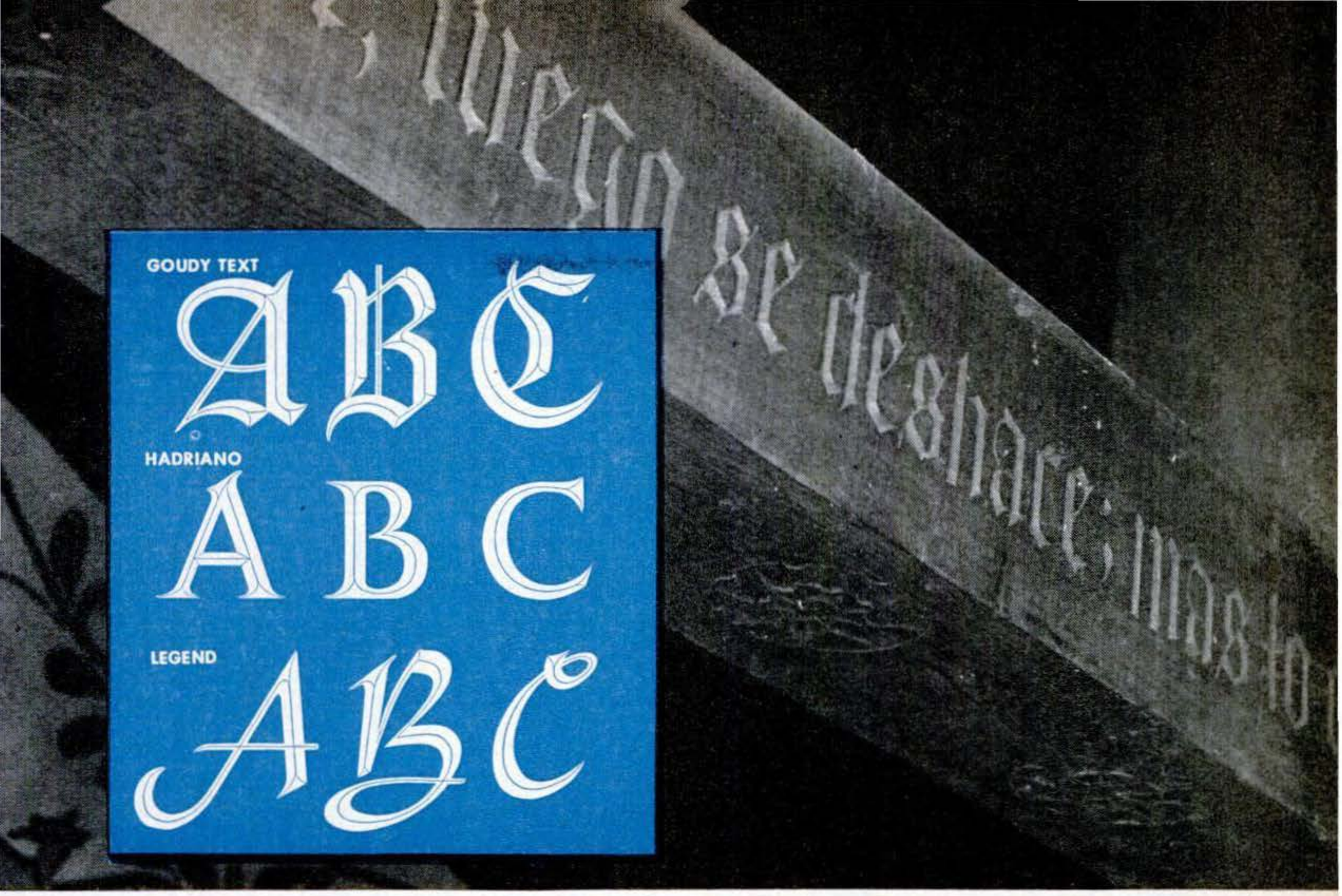
How to Carve Letters in Wood

First step, after laying out the lettering, is to make the vertical depth cut along the approximate center part of each letter.



Sloping inward cut next is made along outline of the letter. On both sides these cuts meet the bottom of the vertical depth cut.





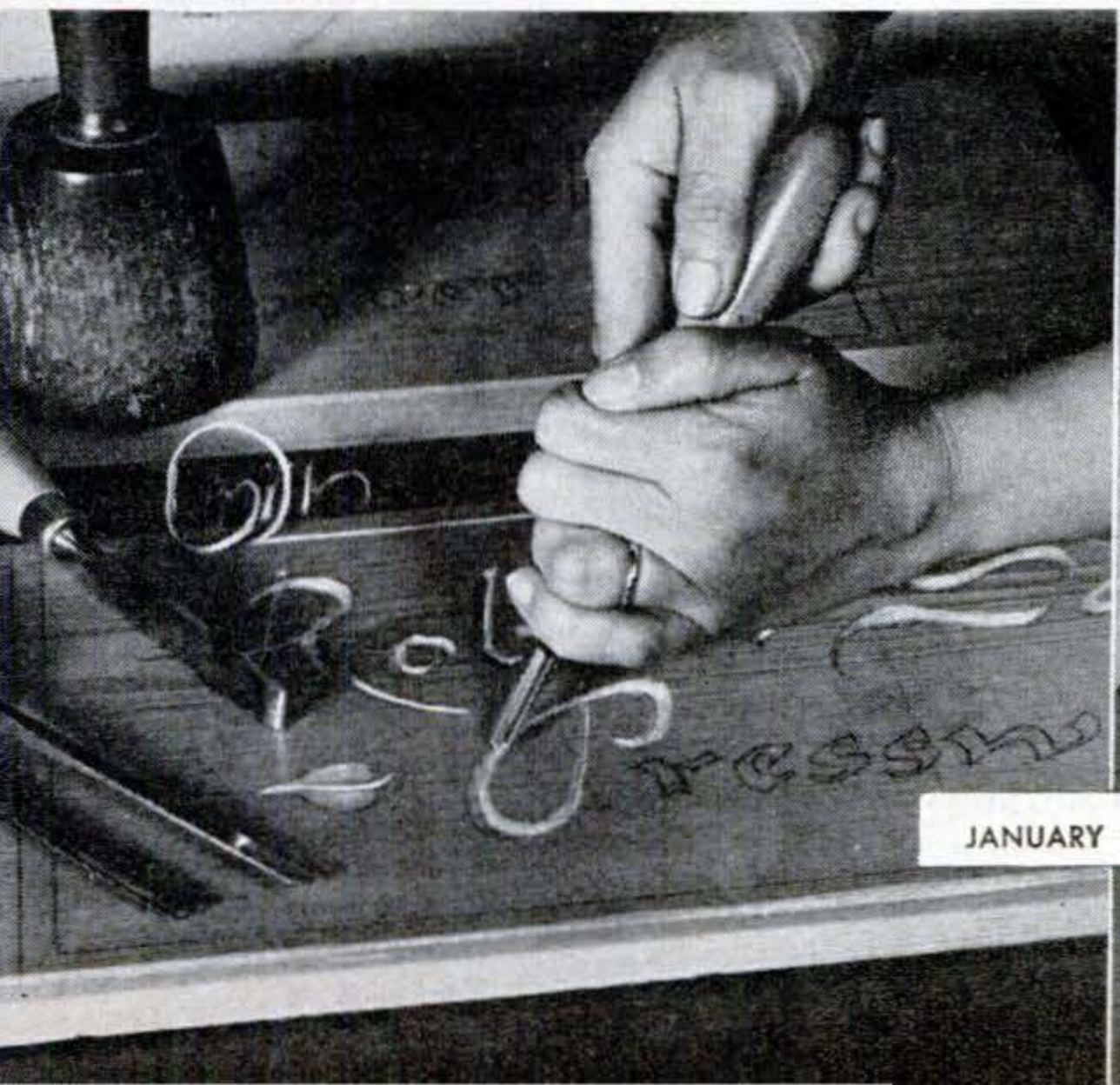
Carved letters also lend themselves to wooden architectural parts, such as this redwood beam.

By Doris Aller

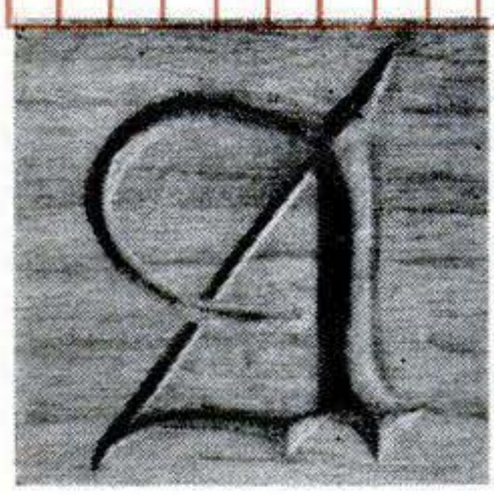
CARVED lettering is one of the most effective forms of decoration for many wooden objects. To personal belongings—the chest pictured on the opposite page—and to beams, doors, and mantelpieces, lettering adds a warm, individual touch. You won't find it too difficult after a little practice, and you won't need an elaborate tool layout. Your kit should include a straight-edged chisel, a V-gouge, and several gouges with varying degrees of curve.

Only incised letters, those formed by carving V-shaped troughs, will be described here. For that reason and because of their adapt-

Depth and sloping cuts leave a V-shaped trough. The bottom of the trough is cleaned out and sharpened by scraping with the V-gouge.



The V-gouge also is used to incise lines. Here the tool is shoved along to cut a straight line for the border of a carved business sign.



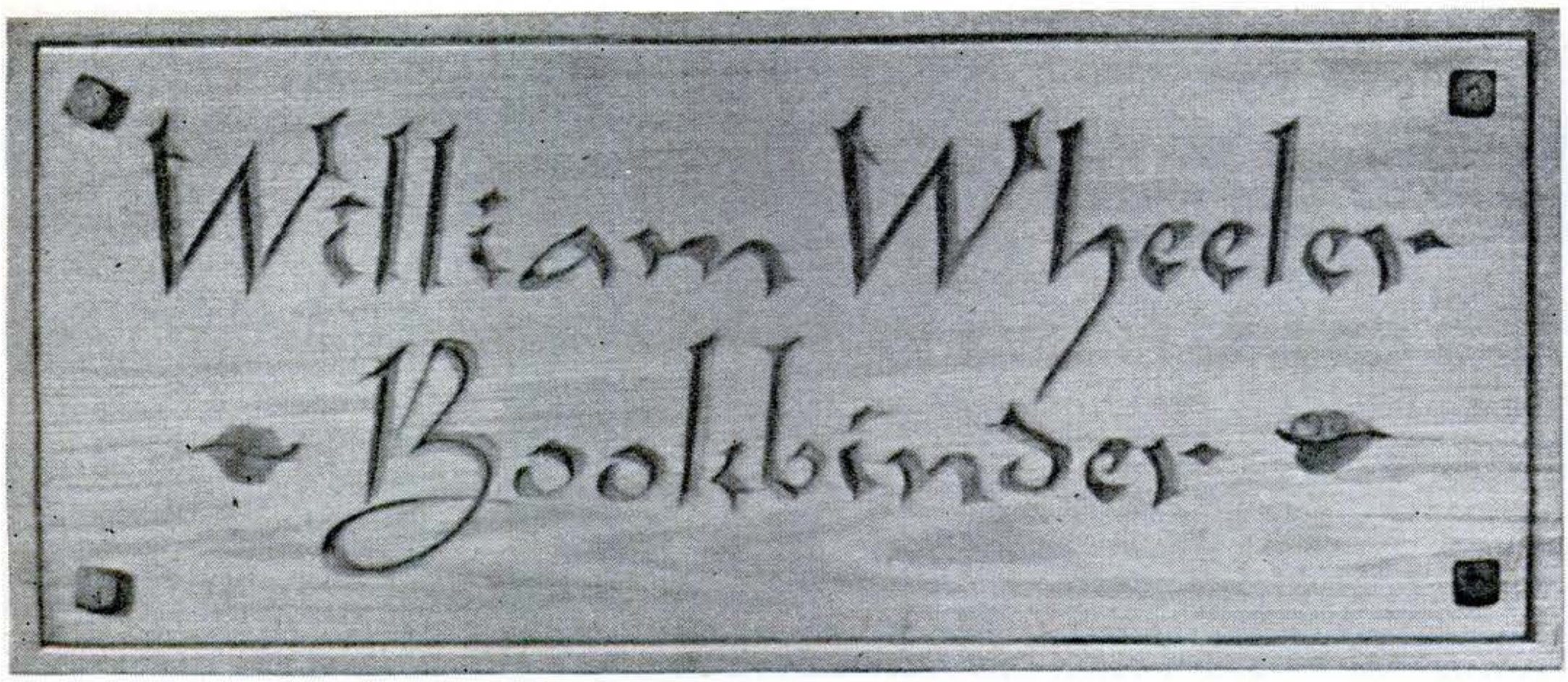
This type face is Goudy Text. At left is example of carved letter A.

ability to carving, I selected the three distinctive type faces given on these pages. The Hadriano alphabet is based on lettering from old Roman inscriptions. There were no lower case letters in the original Roman alphabet and so these letters were designed to form words made up entirely of capitals. The other two alphabets are known as text faces and have both upper and lower cases.

One of the easiest ways to copy and enlarge letters without loss of the original lines and proportions is to make tissue-paper tracings and then blow up the tracing in a photo enlarger. Focus on a sheet of drawing paper or tissue and trace the image with a sharp pencil. If you don't have an enlarger, you can trace the letters on paper lined with larger squares than those shown.

Don't make the mistake of spacing letters an equal distance apart along a rigid bottom line. Instead, the space around each letter —judged in relation to its companion letters —must be considered. Study the three alphabets and numerals and you'll see that letter bases often do not rest on a common line. To force them to do so would destroy the proportions of the whole inscription.

There are only a few steps in the carving of this type of lettering. Lay out the letters you want to carve. Use sharp pencils and



Legend, an unusual type face, is adaptable to business signs. This one is carved in redwood.

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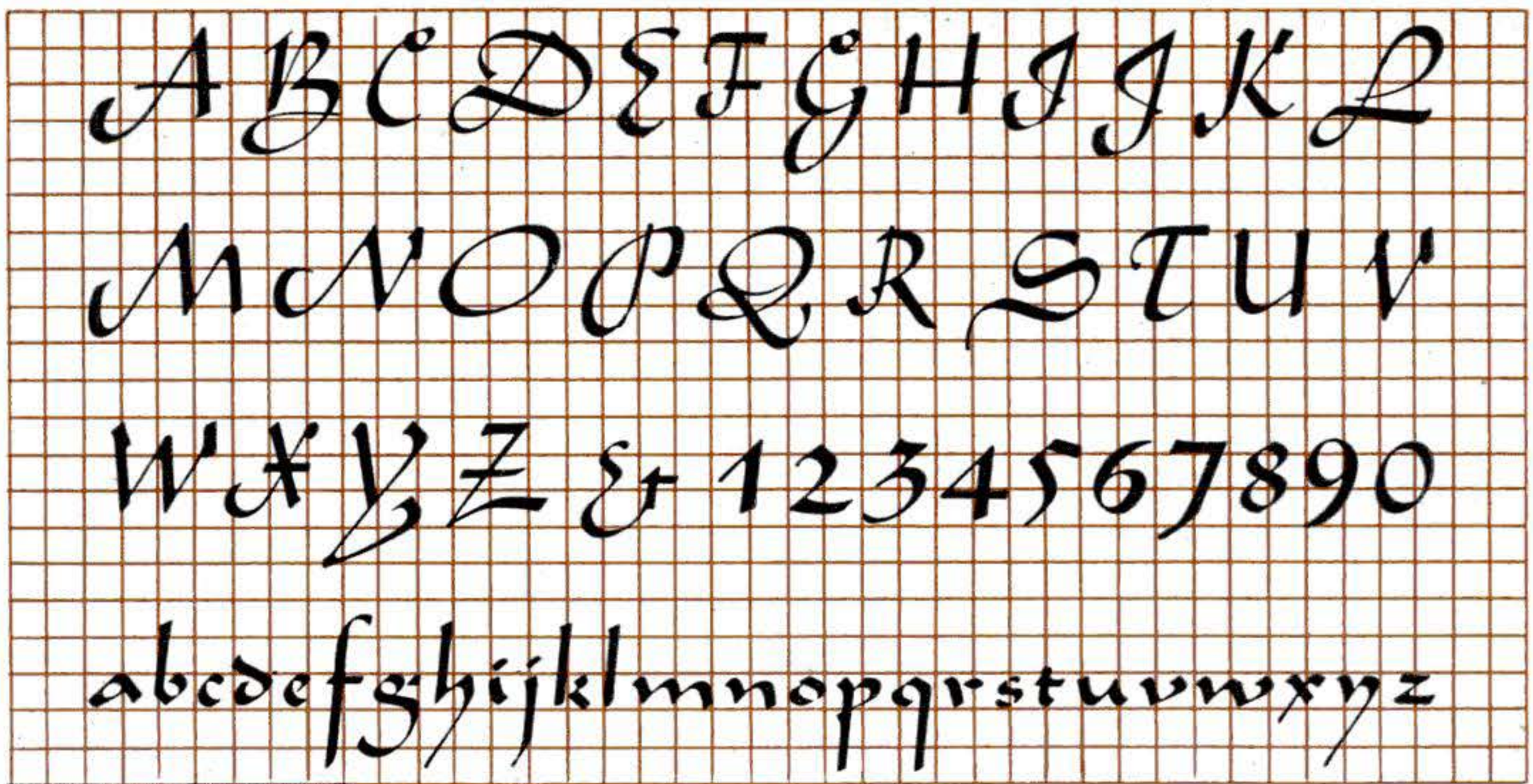
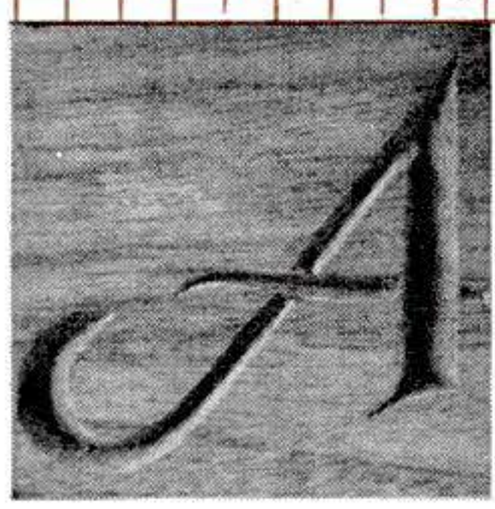
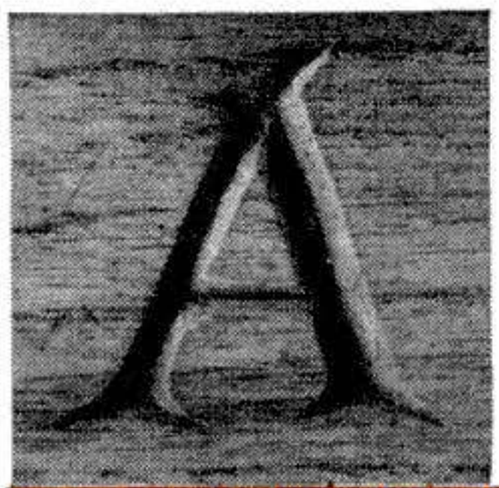


A popular type face with wood carvers is Legend, illustrated above.



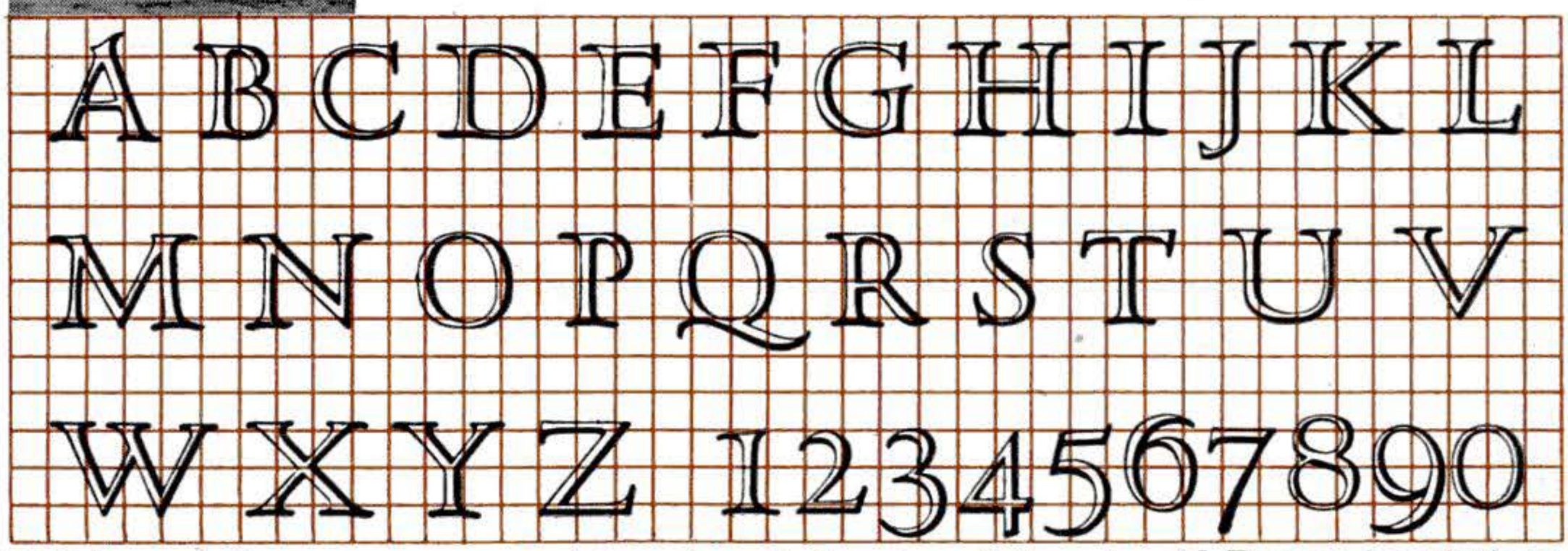
make sharp lines on the wood. First is the vertical depth cut along the approximate center of each part of the letter. In hardwood, you'll need a mallet for this cut. In softwood, a few taps with the heel of your hand will do the job. The depth of the cut depends on the size of the letter and on the degree of boldness you want. Generally, the deepest part of this cut is in the letter's main strokes. The cut becomes shallower at cross strokes, flourishes, and serifs.



Next is the downward, slanting cut along the outline of the letter. It is angled to meet the bottom of the depth cut. When these sloping cuts are made on both sides of the center depth cut, a trough will result.

If the sloping cuts are made with a beveled chisel, the bevel usually is held against the wood. However, on abrupt inside curves, a more graceful cut will result with the chisel used bevel side up. The final step is cleaning out and sharpening the bottom of the trough with a V-gouge.

When carving letters on small objects, it's a good idea to clamp the work to a bench or table top. On large heavy pieces, of course, clamping is unnecessary. The finished work may be stained and wiped to leave the letters darker than the surface. This makes them more prominent. You can also lay paint or gilt in the troughs. Usually, however, a light source at one side is all that is needed to accent carved lettering. END



Hadriano, a clear-cut, easy-to-read type face, is based on letters in old Roman inscriptions.

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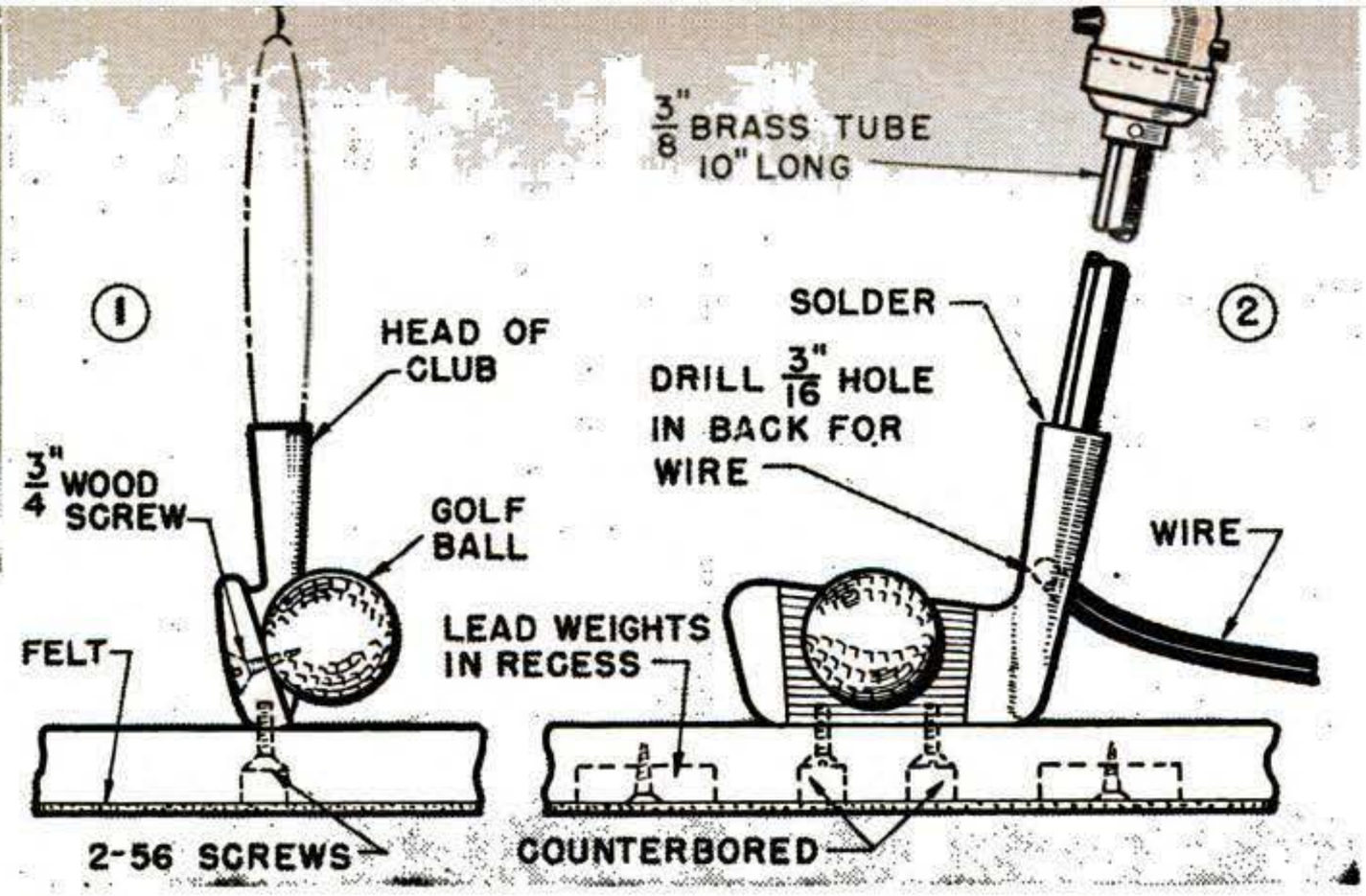
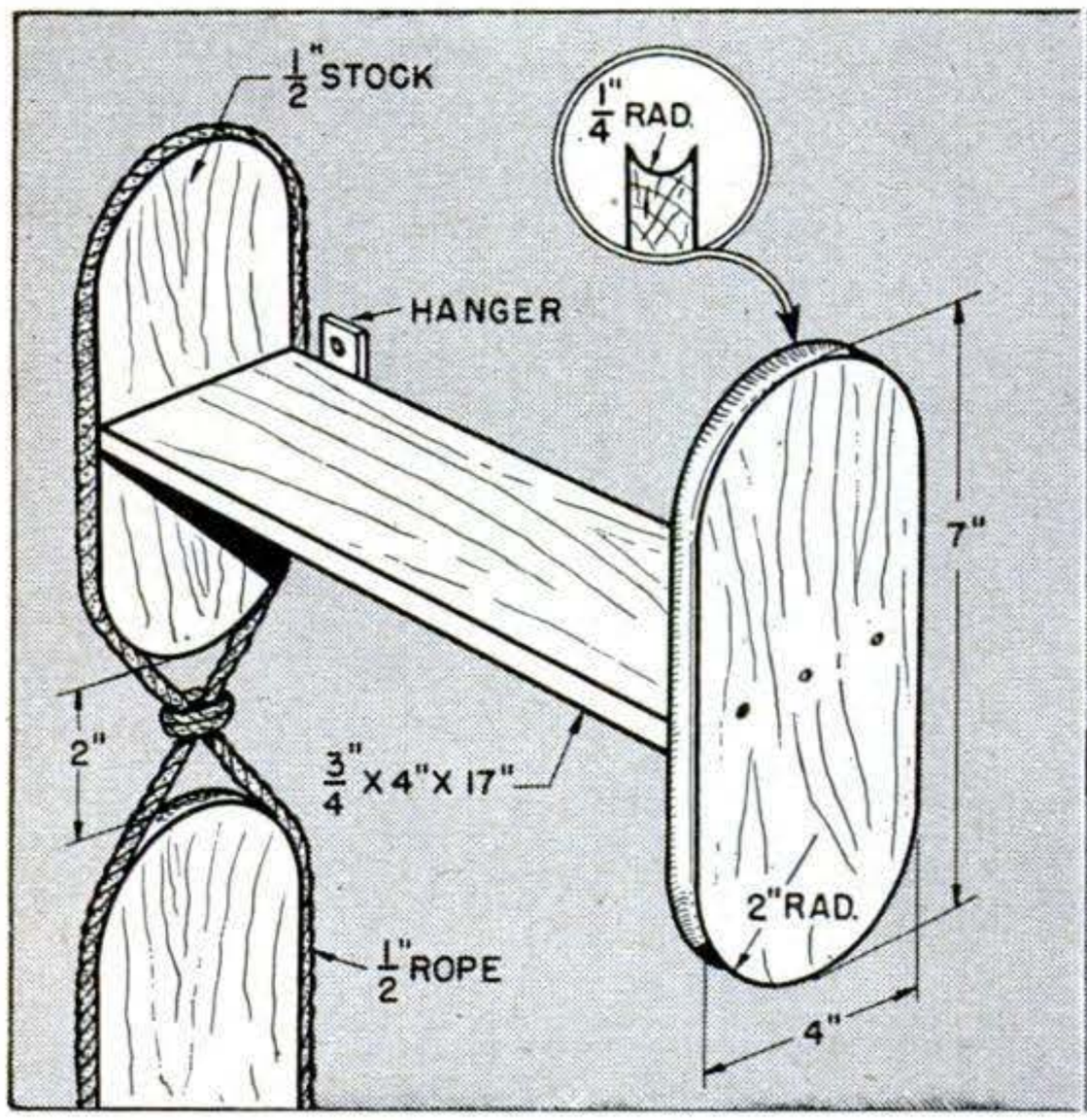
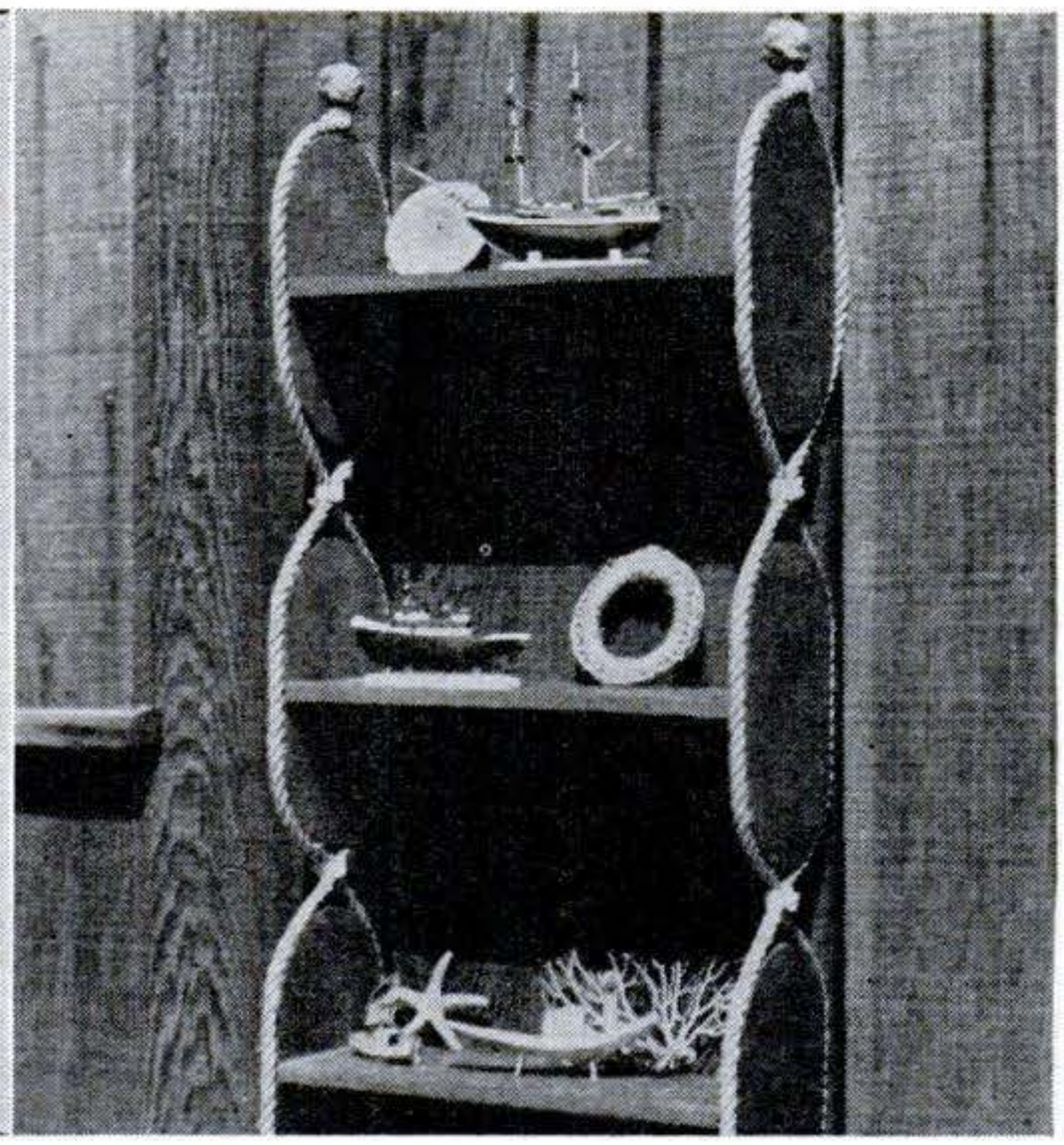


Broken Golf Club Makes Pen Stand or Desk Lamp

My first inclination was to throw the club head as far as I could when one of my irons broke. A second look, however, suggested these two projects. The photo at left shows the head mounted as a pen holder. I cut a piece of wood to an irregular shape and painted it green. The head, drilled and tapped for 2-56 screws, is secured from beneath, while a ¾" wood screw through the head holds the ball. In the drawing at right is shown a variation of the same idea. Solder a 10" piece of ⅜" o.d. brass tubing into the head and thread the upper end for a lamp socket, using ⅛" pipe thread. Drill and bush a hole for the wire. Hollow out the base and screw lead or brass strips in it. This gives the base the added weight it needs for lamp use.—*Herbert Pfister, Bronx, N. Y.*





Bosun's Ladder for Models

Souvenirs of the sea and models of ships are shown to advantage in this appropriate setting. Construction calls only for three pairs of oval sidepieces that are joined to the three shelves with finishing nails. Grooves in the edges of the sides, as shown in the drawing, hold the ropes in place. A pair of screw brackets in the top shelf are used to hang the bosun's ladder on a wall.—*Hi Sibley, Nuevo, Calif.*

Wire Improves When Soaked

A new electrical wire with rubber insulation that increases in effectiveness when soaked in water has been developed by the United States Rubber Co. It is designed for underground use in wet localities where high moisture resistance is required for safety and long service.

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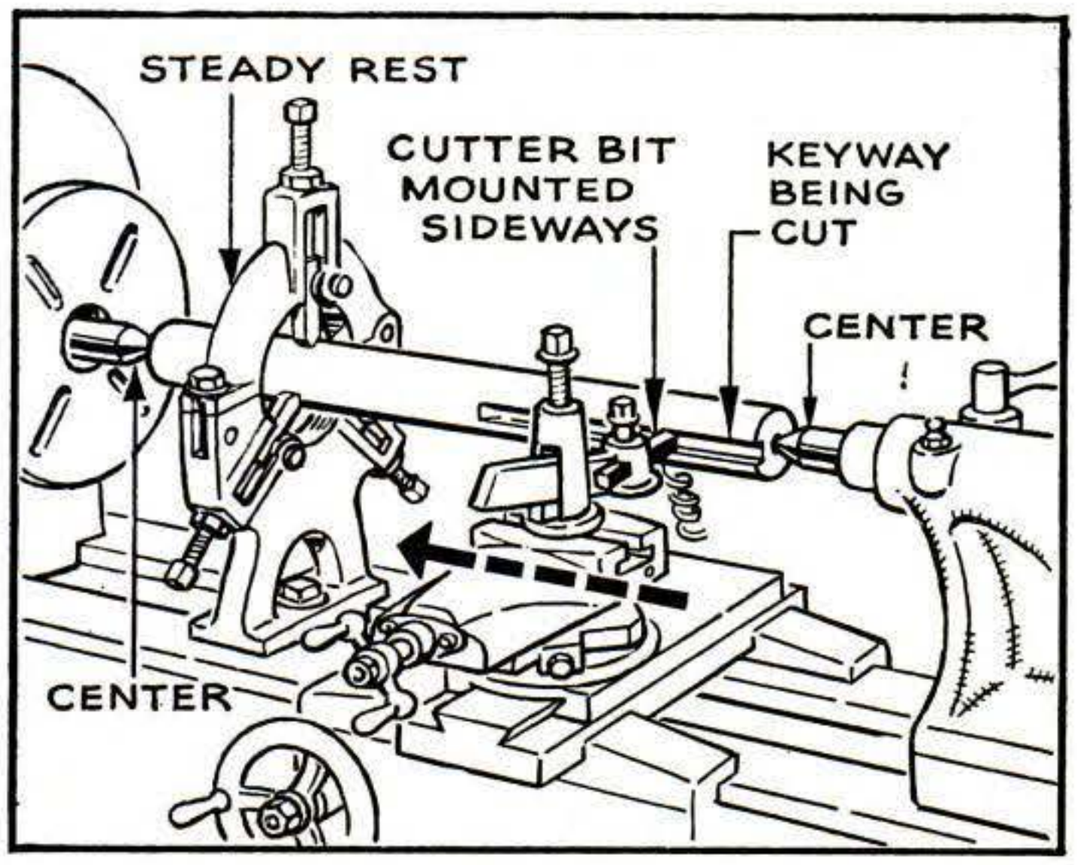
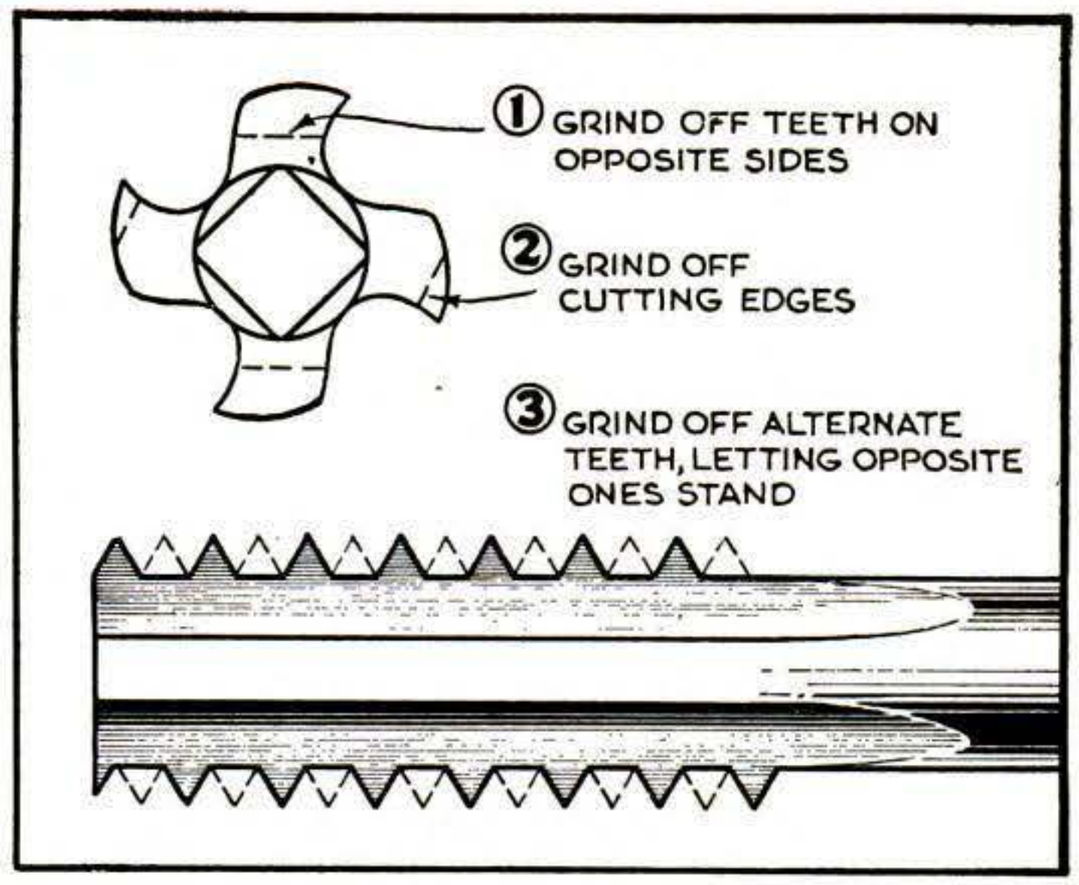
Outboard Boat Folds Up to Form Its Own Trailer

HINGED near the center, this 13′ boat folds over to make a trailer body capable of hauling a 300-lb. load at normal road speeds. The boat, developed by Robert Sanborn, of Rock Creek, Ohio, is of waterproof plywood on an oak frame. Unfolded, a pair of sliding rods lock the two sections rigidly together. The tubular-steel trailer, weighing about 100 lb., rolls on two individually sprung wheels. To launch the boat, the rear section is swung back and locked. Then the trailer is rolled into the water and unlocked from the boat. The frame is swung upward, lowering the boat into the water. Then the frame is rolled back up on land.—*Walter E. Burton, Akron, Ohio.*



Keyways Cut Without Milling

WHEN you have to cut a keyway and don't have a milling machine, a screw-cutting lathe will do the job. Place the shaft between centers, not using a driving dog. On the end nearest the headstock, place a steady rest and clamp it up tightly on the shaft. The lathe then can revolve without the work turning. By using slow speed and engaging the carriage feed, a very satisfactory key-cutting job can be done. Put the tailstock center in the headstock, since that center is hardened.—*H. W. Pott, Victoria, B. C.*



Making a Left-Hand Tap

HERE'S how to take an ordinary, four-fluted right-hand tap and make a left-hand tap from it. First, grind off the teeth on opposite sides. Grind to the full tooth depth all along the tap. Next, grind away the cutting edges of the two remaining rows of teeth. This removes most of the right-hand pitch and makes it possible to tap a hole for a left-hand thread. Then remove every other tooth from both rows. Don't remove teeth opposite each other. Stagger them. Use a grinding wheel with a sharp, square edge.

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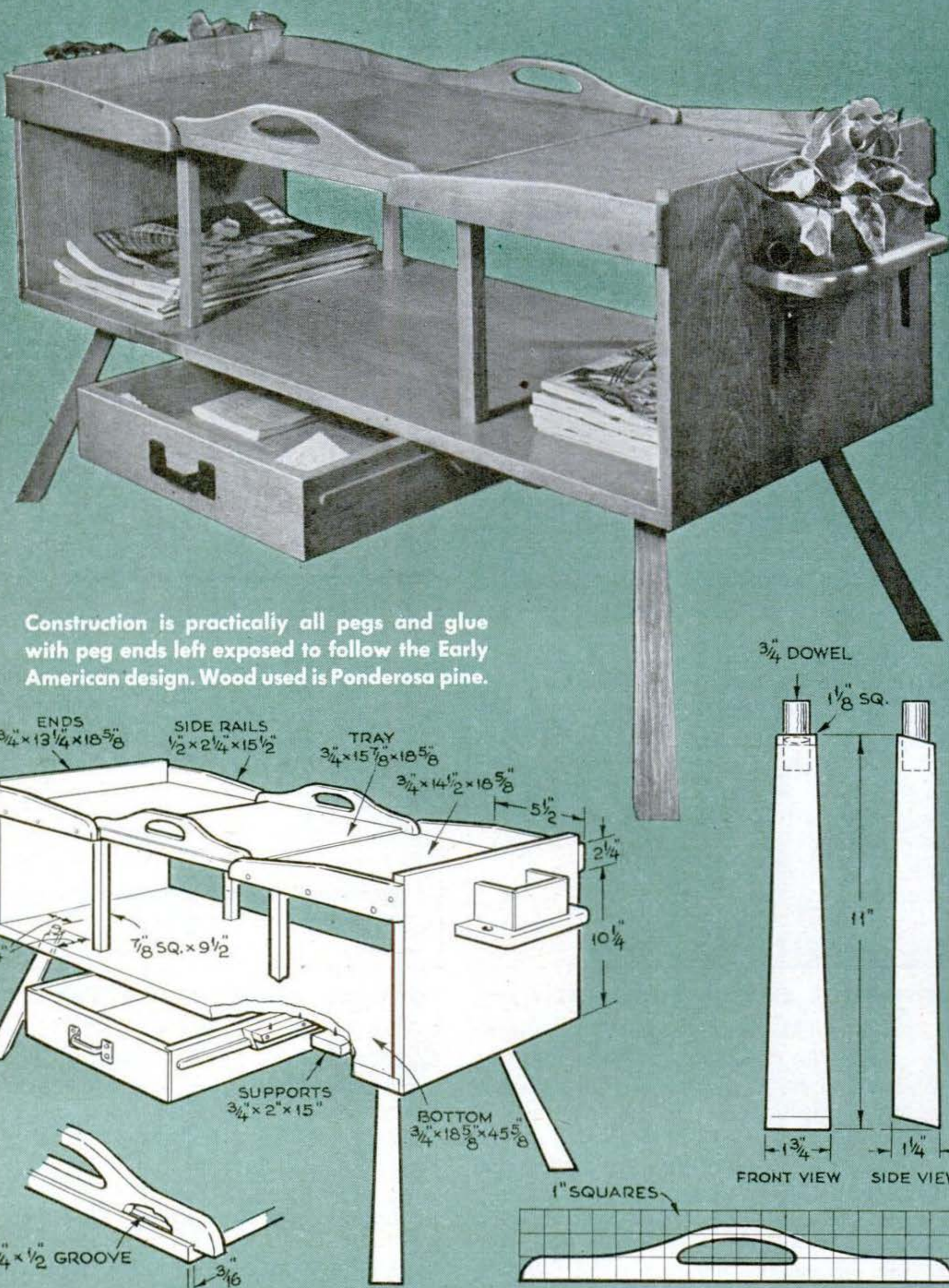
Big and rugged, this man-sized table has plenty room for everything from magazines to pipe and tobacco. Added touches are a serving tray and a two-way drawer.



Construction is practically all pegs and glue with peg ends left exposed to follow the Early American design. Wood used is Ponderosa pine.

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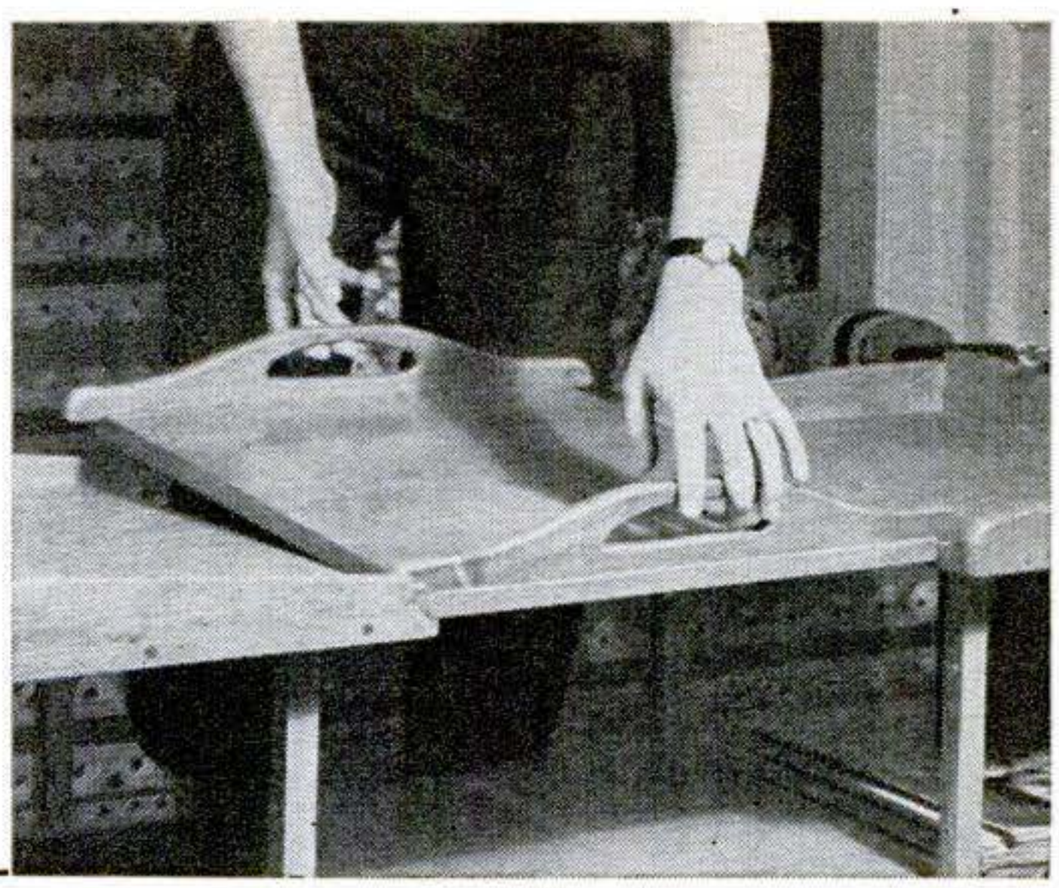
Double-Deck Table Has Removable Tray



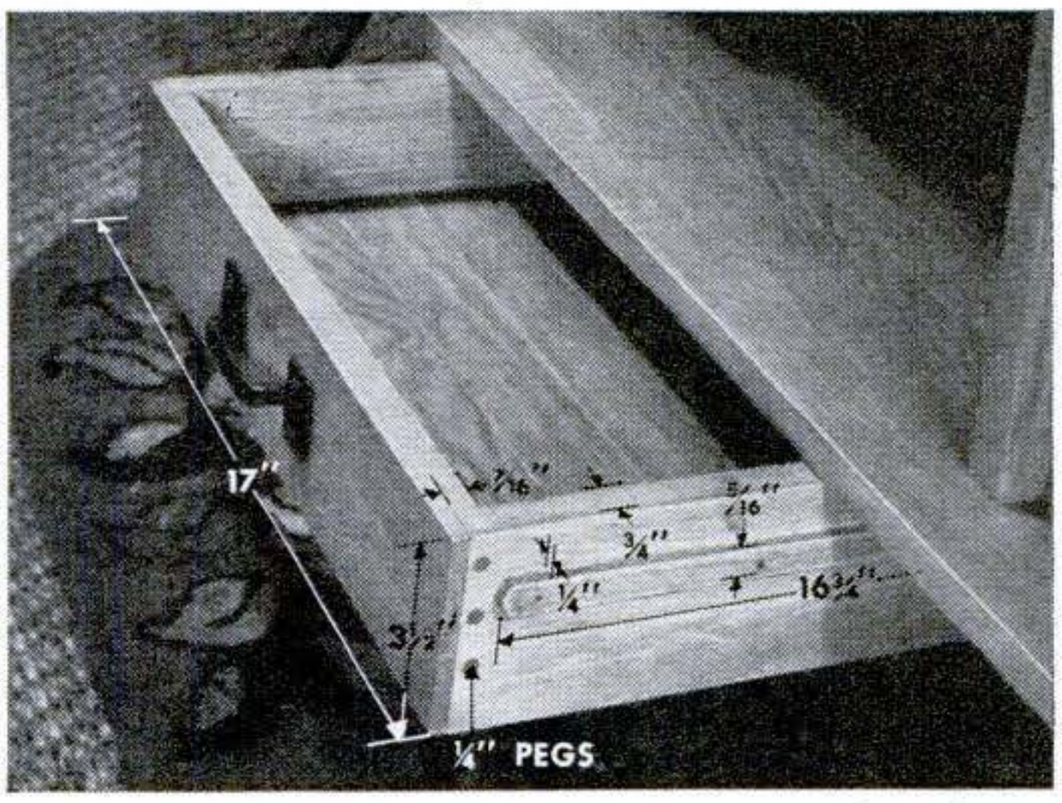
THE removable tray is the big feature of this husky table. When it is brought in loaded with drinks or sandwiches, there is always a place to put it down without shifting ash trays and knickknacks around. It simply rests across the two top shelves.

Construction—dimensions are on the drawing on the facing page—is mostly a glue and peg job. I used 1″ by 6″ dressed pine. Wider boards aren't very practical; they may develop a warp. The first step is joining and gluing the base. Use dowels, hot glue, and clamps. After the base has set for at least 12 hours, plane it smooth. Then glue and screw the braces in place at each end.

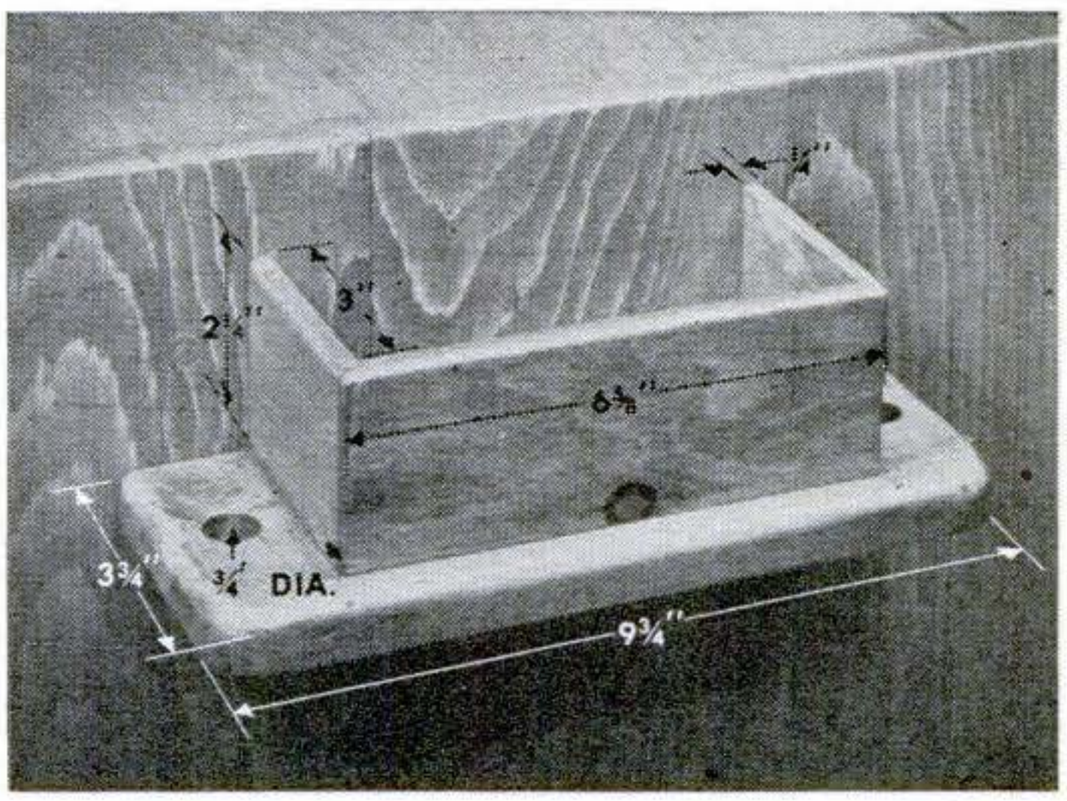
Assemble the drawer guides but do not install them until the drawer is finished. In making the drawer, be sure each end is of clear lumber. Both ends of this drawer are exposed since it can be opened from either side of the table. Place the table base upside down, center the drawer on it, and glue and screw on the drawer guides. Leave a little play to prevent the drawer binding.

Make up both ends as one piece, using glue and dowels. After the glue has set, saw the piece in half to make two ends. When joining the boards for this piece, make certain the dowels are not placed where you will have to saw. Cut a rabbet joint where the ends meet the base. The two shelves are also made in one piece and later sawed.

Here's a neat dodge for attaching the legs. Cut them from 2″ by 3″ stock but before tapering them, drill a ¾″ hole in one end of each for a dowel. If you do this before tapering, there'll be much less danger of splitting the legs. Take a 6″ piece of scrap two-by-four and drill a ¾″ hole through it at the proper angle for the legs. Place it on the bottom of the table with the hole where you want the leg to be. Clamp the block in place. Then run a ¾″ bit into the hole and drill with the hole in the block as a guide. Clamp a piece of scrap where the drill will come out to prevent tearing the surface of the base.—*William Reigel, Los Angeles, Calif.*



Roomy and accessible from either side of the table, the drawer is put together with glue and pegs in the simple rabbet joints.



Construction of the end boxes is straightforward. They are held with glue and brads. Use them for flowers or for a tobacco humidor.

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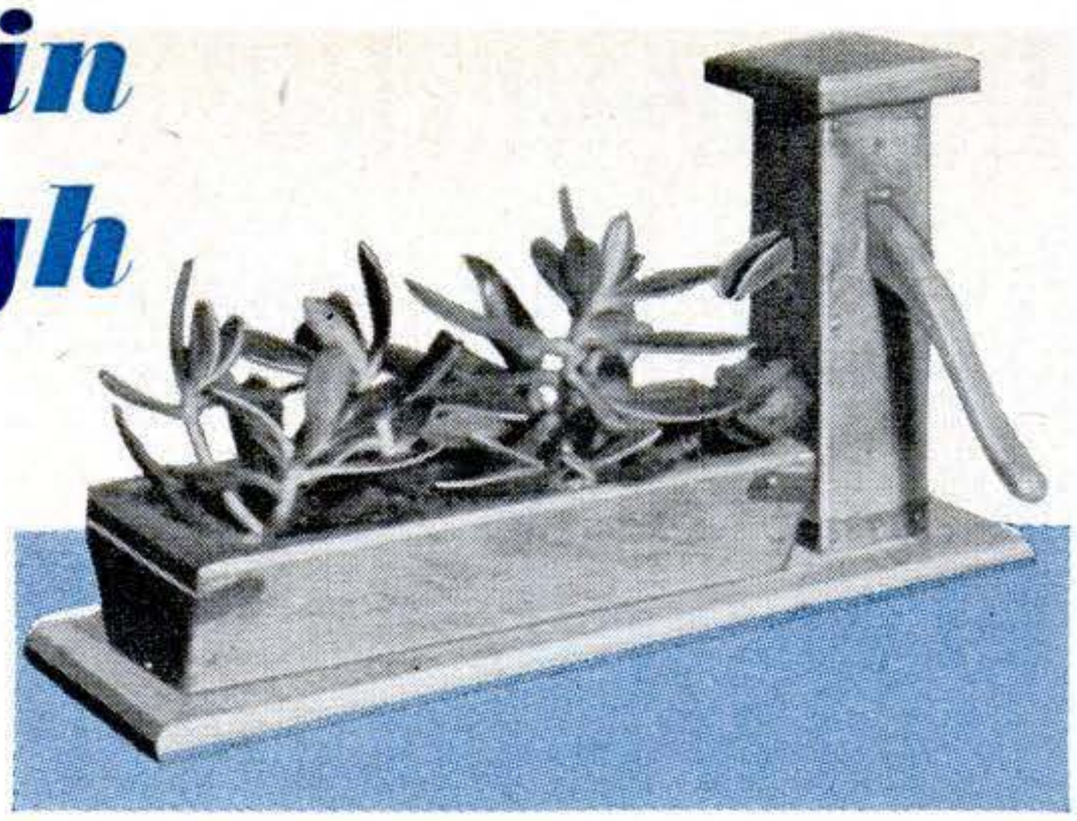
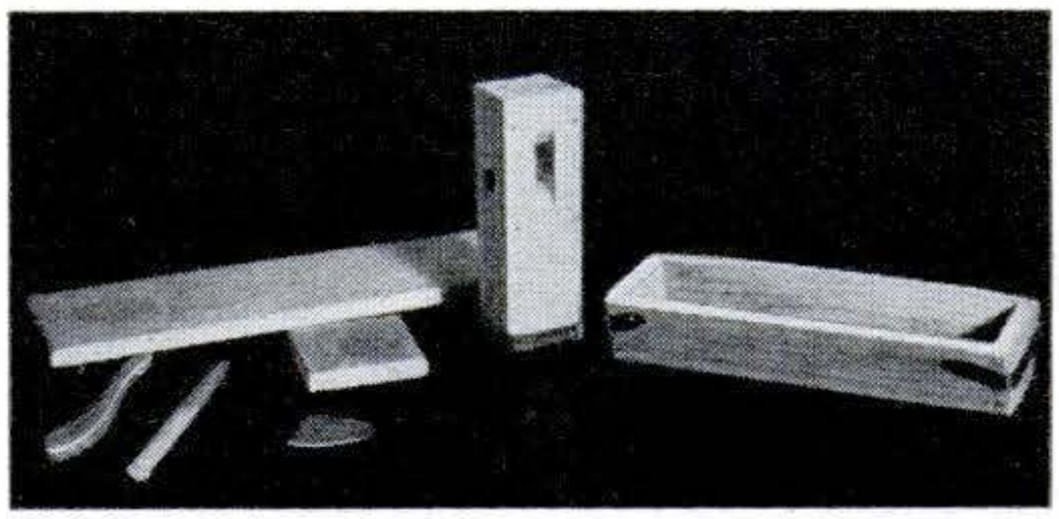
Plants Grow in Midget Trough



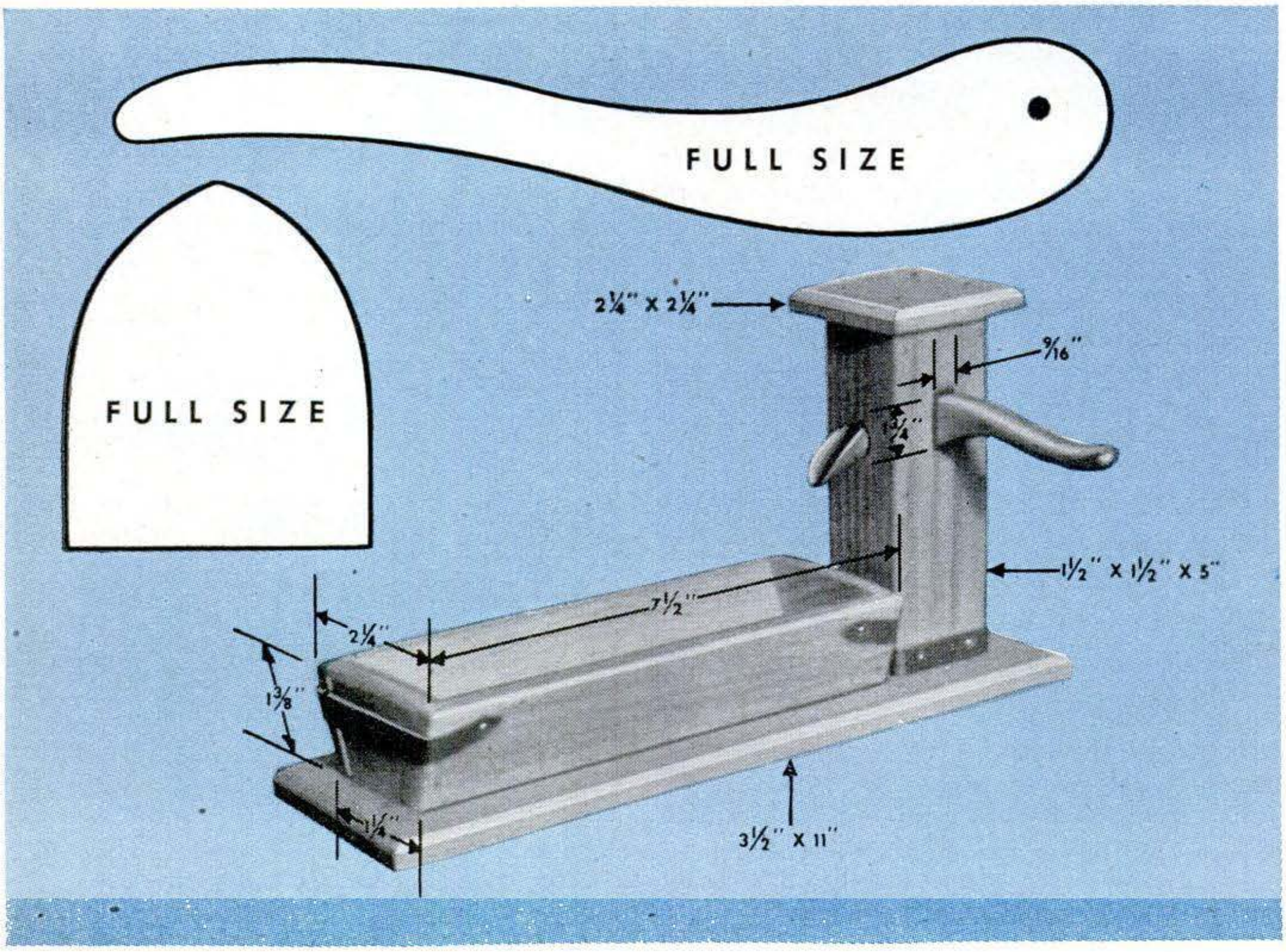
BOUND with copper bands and studded with escutcheon pins, this miniature duplicates the familiar old farm pump. You can use almost any wood, but the one pictured here is pine, assembled with brads and glue. All pieces, except the pump housing, are ⅜″ stock. Other dimensions are given in the bottom photo.

Cut out and assemble the trough first, using 20 gauge copper for the ⅜″ by 4⅝″ bands. Lap the sides over the ends and dress the four pieces to sit flat on the base. Fit the band on the pump housing with the joint beneath the water spout. Cut the spout from 20-gauge copper and form it over a ⅜″ dowel. About 3¼″ from the bottom of the housing, drill a ⅜″ hole ½″ deep to take the spout. Mortise the slot for the movable pump handle about ¾″ deep. Use a No. 4 finishing nail for the pivot, but first drill a pilot hole to avoid splitting housing or handle. Attach the top of the housing with four copper or brass pins.—*W. K. Towers, Los Angeles.*

Before planting the trough, give the interior a coat of thinned tar to waterproof it. Finish the exterior with shellac or clear varnish.



Sand off all sharp corners and edges to give the parts a well-used look. Dowel shown near handle is used in forming the water spout.



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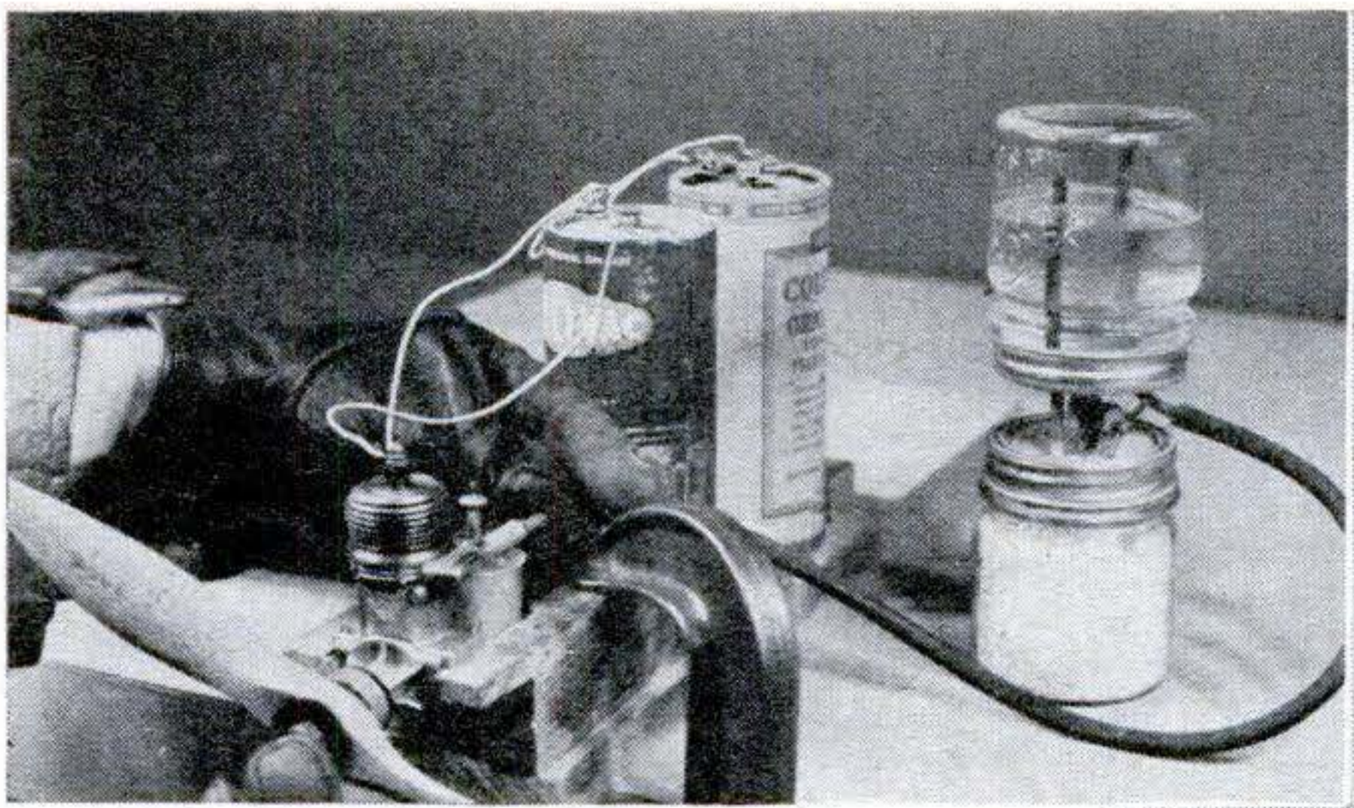
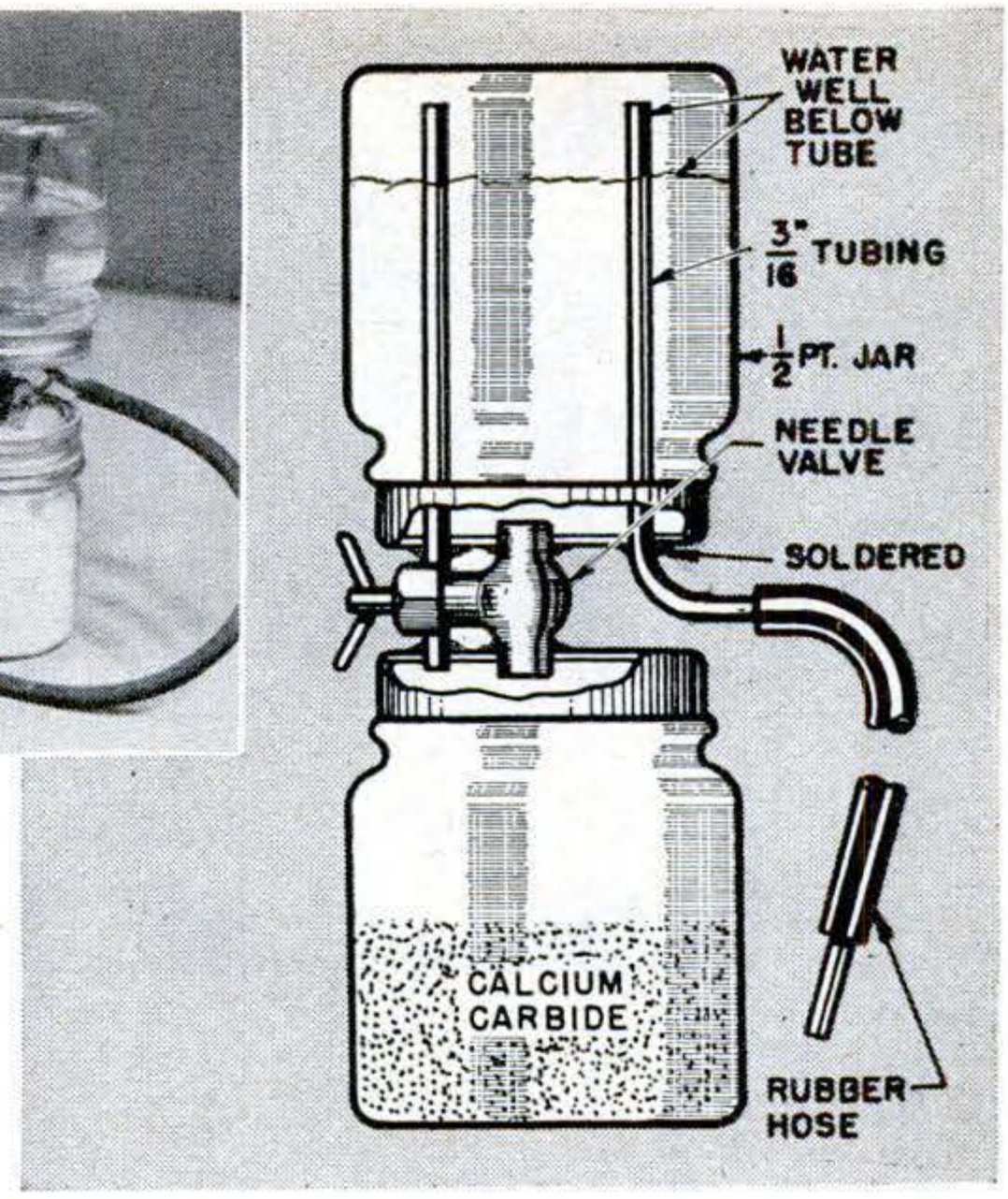
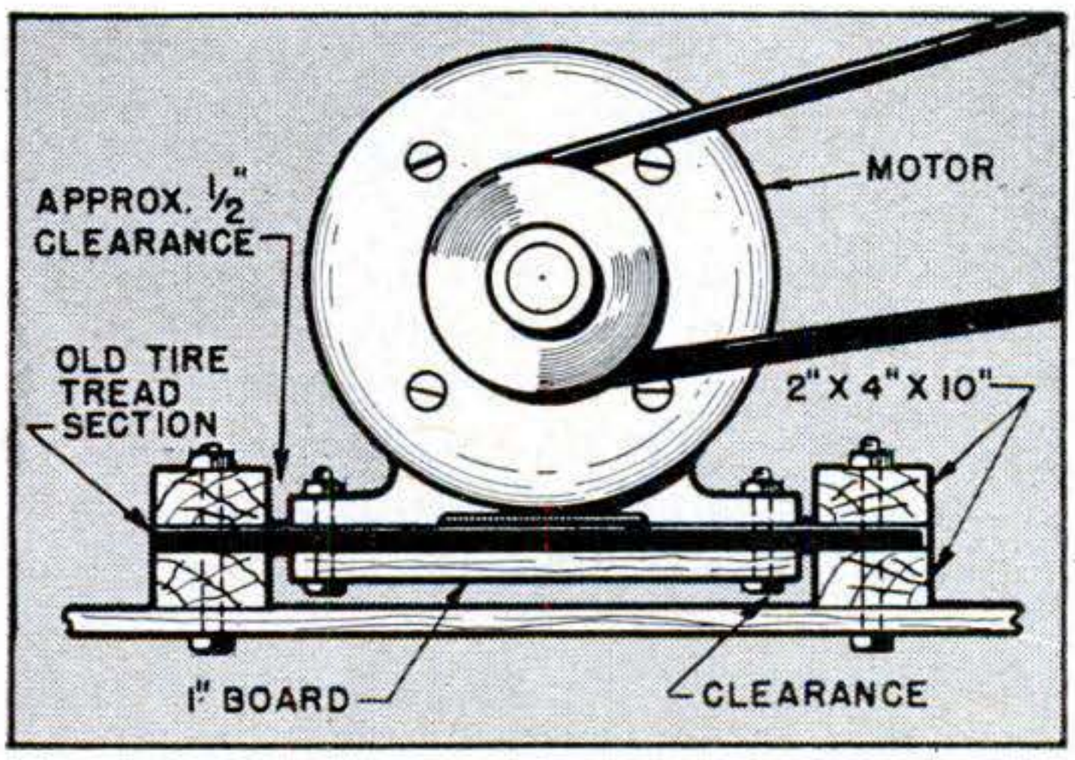




Acetylene Starts Model Engine

BALKY, hard-starting model gasoline engines often kick over easily on acetylene gas. Unlike most fuels, it does not have to be mixed with air in very exact proportions to ignite. Rig up the generator as shown in the drawing. I used a needle valve bought at an auto store. Place a little calcium carbide in the bottom jar and open the valve just enough to let water drip slowly on the carbide. Hold the hose nozzle close to the intake of the engine. With the ignition on and the regular fuel valve part way open, give the prop a few turns. As soon as the engine starts firing, move the nozzle around to find the spot where it picks up speed, and then switch over to regular operation. Don't run an engine too long on acetylene, since it may overheat. Don't store or use the generator indoors. Also wear gloves in case a backfire ignites the gas at the hose nozzle.—*D. G. Pittwood, Moscow, Ind.*



Substitute Mount for Motor

THE drawing above shows a set-up I recently used to mount a ½-hp. motor when the conventional rubber mounts were not available. Although cutting a section from a discarded auto casing calls for some extra work, I found that this method was more satisfactory than using the regular rubber bushings. However, you have to be careful that there is plenty of clearance for the bolts. The 1″ board under the motor and the motor itself must not touch the bench. —*R. L. Dickey, Memphis, Tenn.*

Masking Tape Has Apron

TREATED to resist paint and lacquer, Maskwik® combines both paper and gummed tape. It speeds masking operations because the adhesive is a part of the paper, making it unnecessary to handle tape and paper separately. The material is manufactured by Stratocote, Inc., of Los Angeles, Calif., and is available in widths of 2″ to 36″ with either one or both edges gummed.

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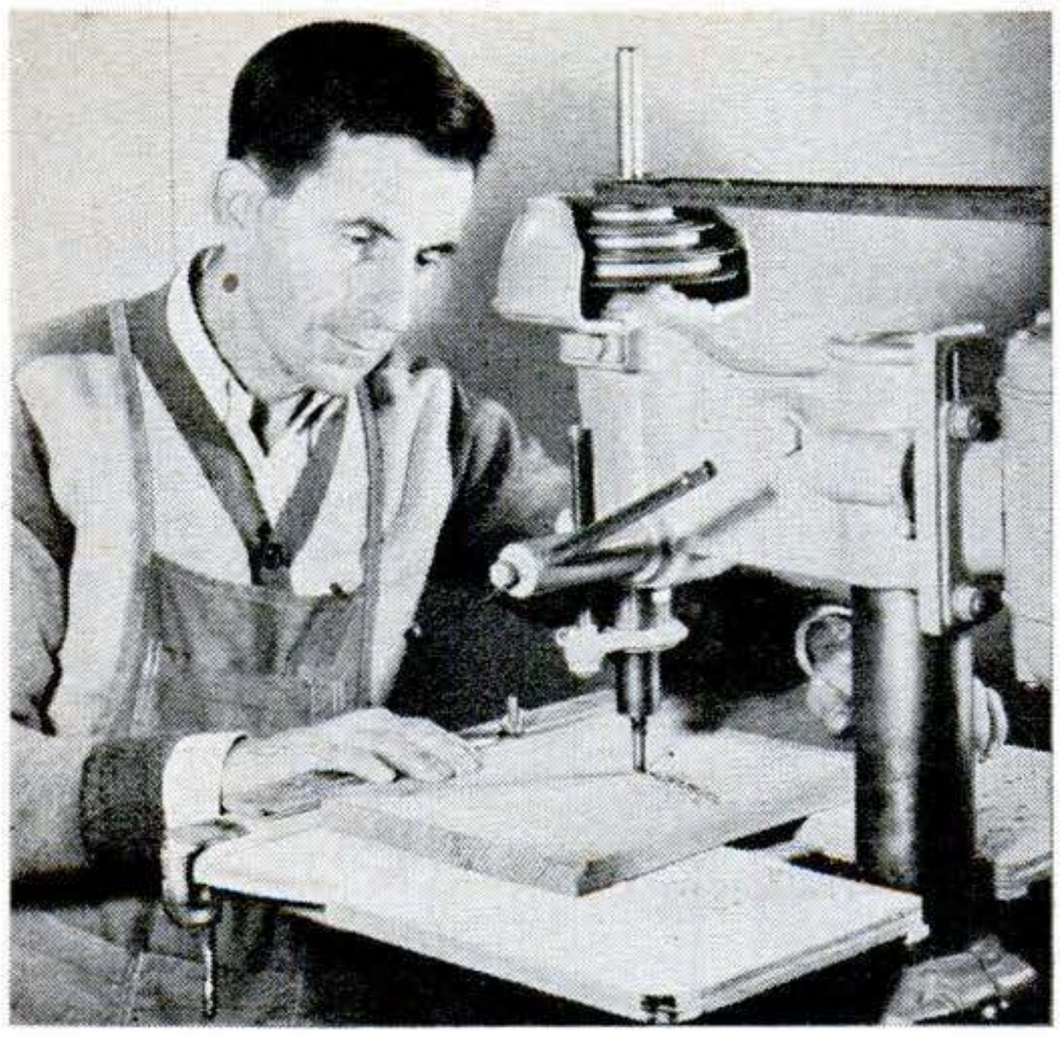
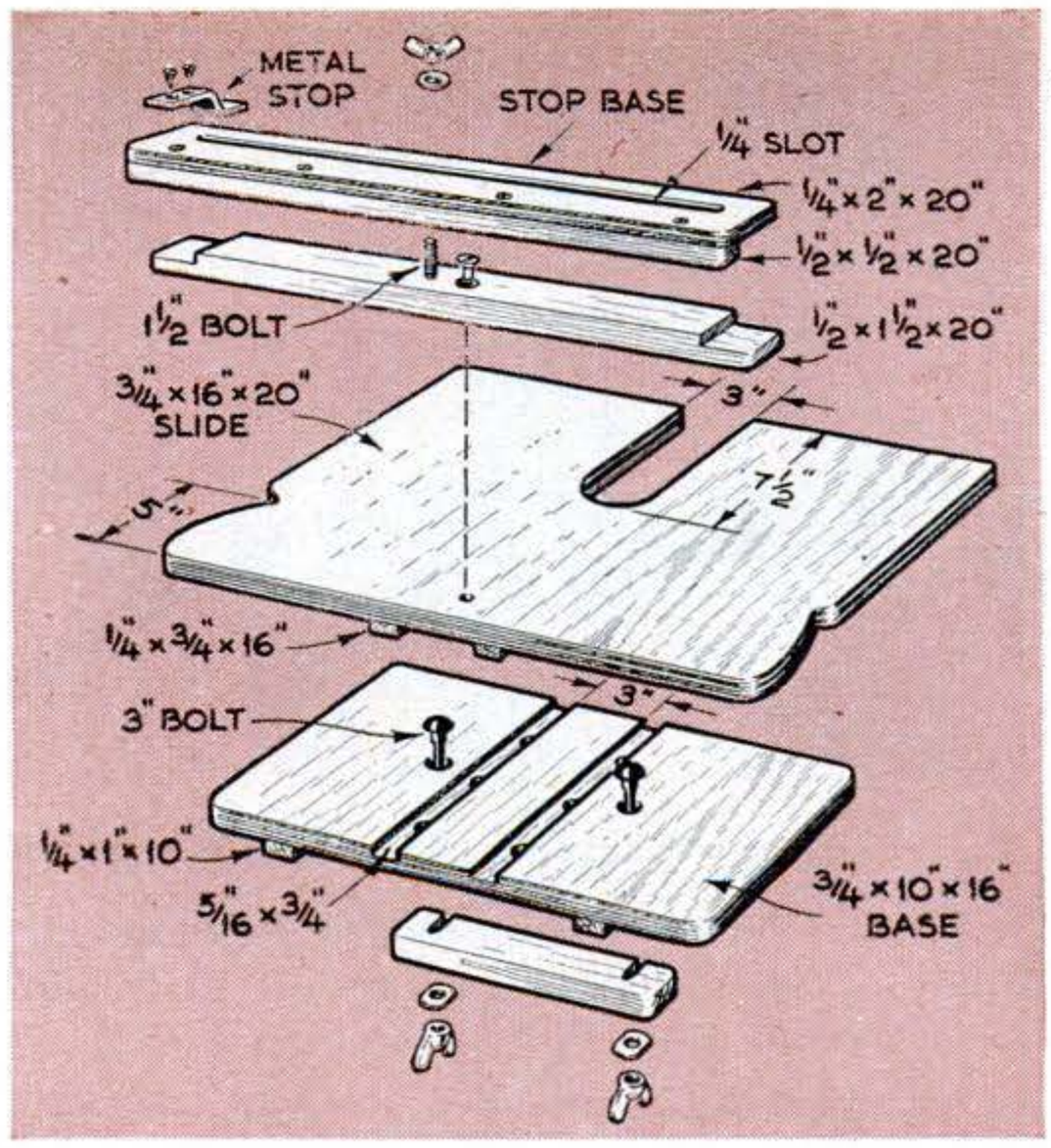


Stop dadoes are a cinch with this jig. Bore in at starting point and feed work away from you.



Dado Jig Cuts 'Em Quickly

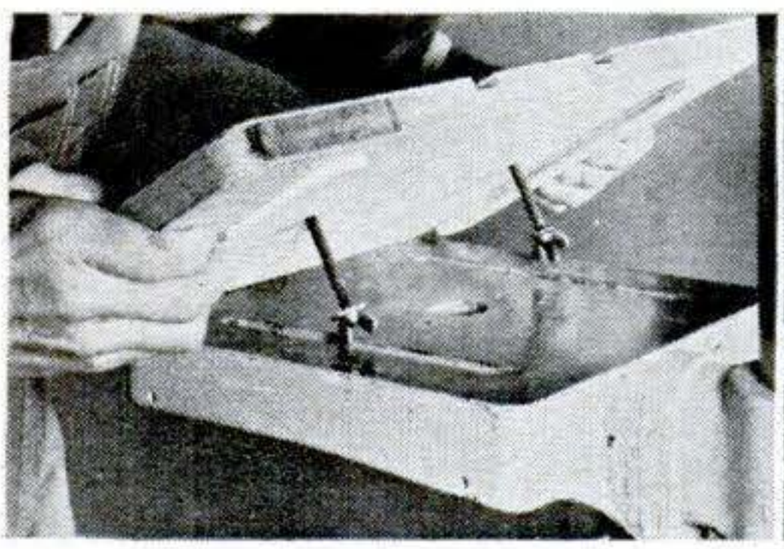
WITH this jig, a router bit in your drill press becomes the ideal tool for cutting stop dadoes. Designed for a quick setup, the jig consists of a grooved base bolted to the drill-press table, a wide sliding table, and an adjustable fence and stop.

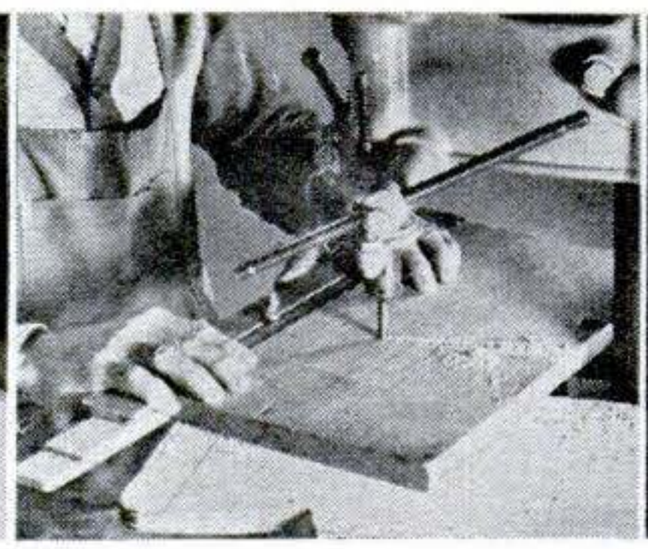
Two hardwood runners underneath the plywood table slide in grooves in the base. The fit should be such that, after waxing, the runners will move freely without side shake. To align the runners, attach one along a line squared from the front edge. Then invert the finished base over it and screw down the second runner in the other groove, putting the screwdriver through access holes bored in the groove.

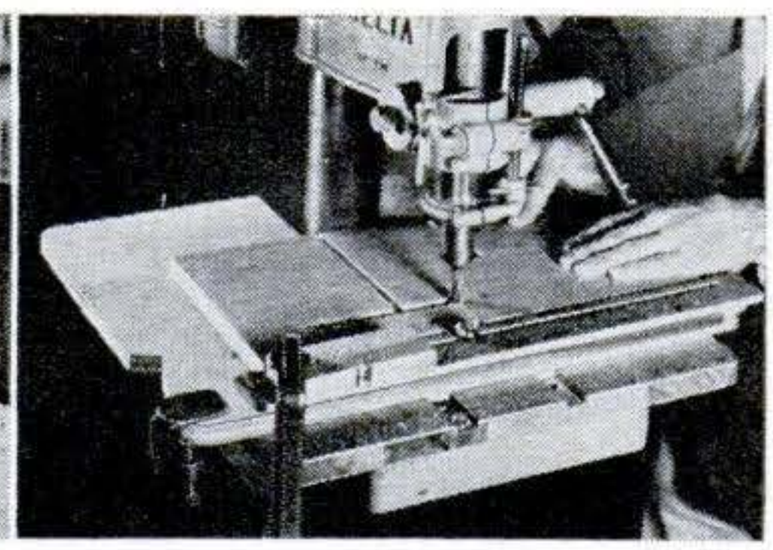
Cut a slot in the sliding table to allow it to clear the drill-press column. Round the front corners to make it easier to clamp the fence when the latter is swiveled to cut dadoes for tilted shelves. Notch the fence at the ends for clamps, pivot it with a wood screw, and install a 1½" carriage bolt for attaching the slotted stop base.

To use the jig, mark the dadoes and lay the work on the jig. Lock the routing bit at the desired depth. Slide the fence stop against the left end of the work, set the clamp, and start up the drill press. If both ends of the dado are to be stopped, raise the bit, slide the table to the starting point, and lower the bit. Do not back out while the cutter is turning. Square the rounded ends with a chisel.

For lengthwise grooving or slotting, clamp the sliding table to the base. Then slide the work along the fence, feeding it from the right.—*Edwin M. Love, Palmdale, Calif.*







Wing nuts and squared washers slip through the drill-press table slots without the bother of removing them. The nuts are tightened against a hardwood strip slotted on one side to slip over the bolts. Dadoes for tilted shelves are cut by swiveling the fence as seen in center photo. Lengthwise grooves are made by clamping the table and sliding work along the fence.

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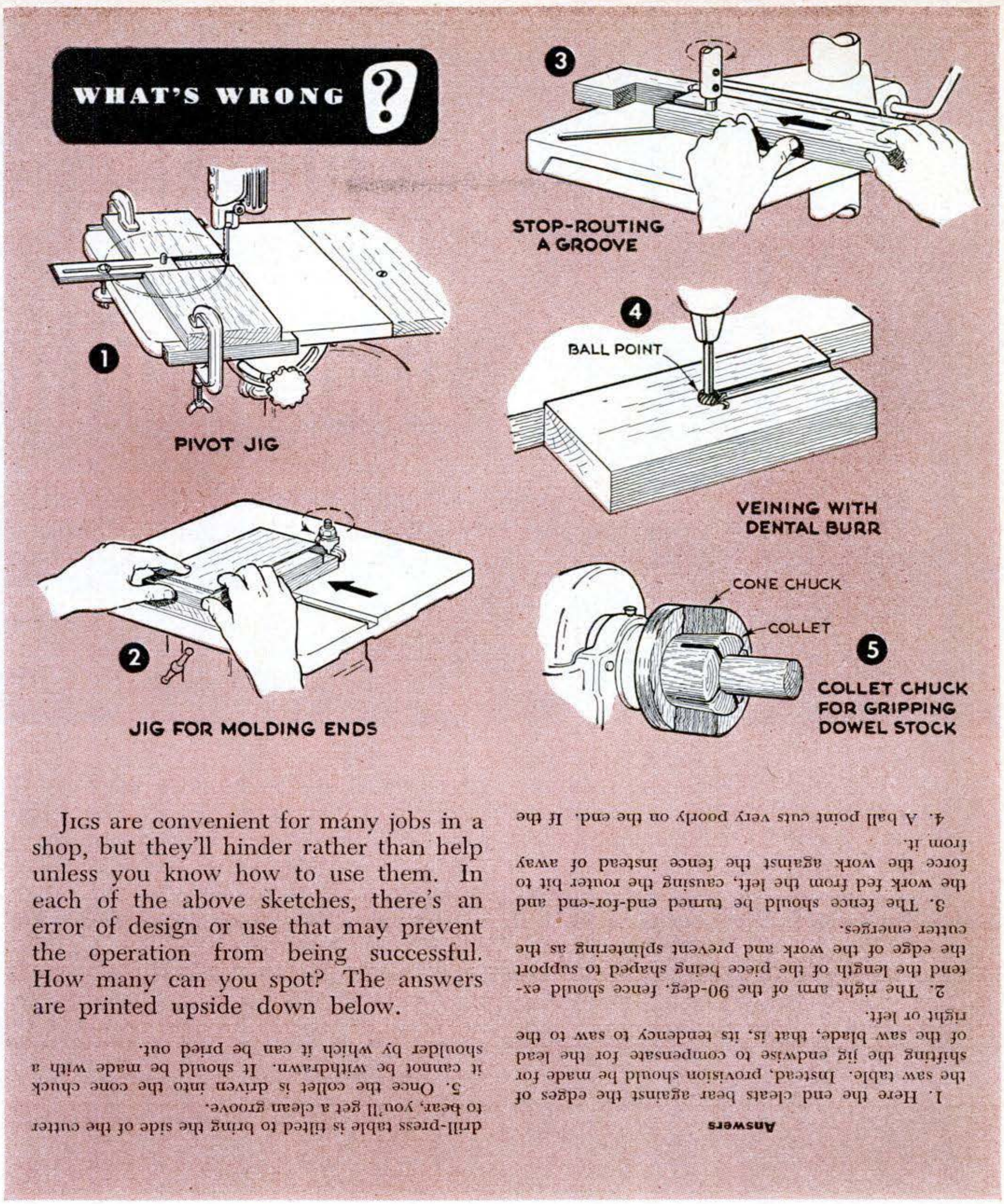


JIGS are convenient for many jobs in a shop, but they'll hinder rather than help unless you know how to use them. In each of the above sketches, there's an error of design or use that may prevent the operation from being successful. How many can you spot? The answers are printed upside down below.

Answers

1. Here the end cleats bear against the edges of the saw table. Instead, provision should be made for shifting the jig endwise to compensate for the lead of the saw blade, that is, its tendency to saw to the right or left.

2. The right arm of the 90-deg. fence should extend the length of the piece being shaped to support the edge of the work and prevent splintering as the cutter emerges.

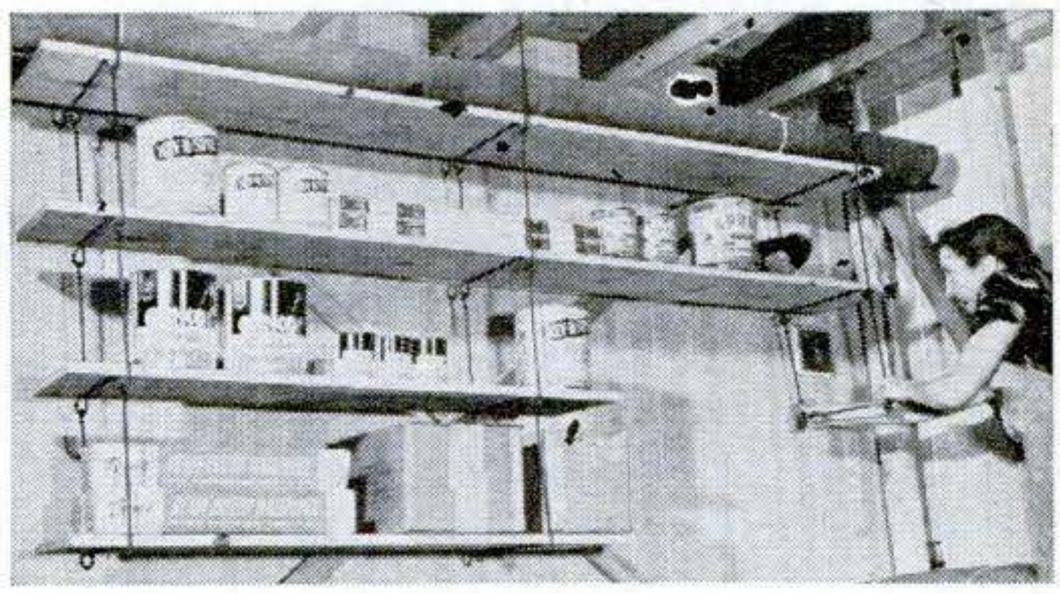
3. The fence should be turned end-for-end and the work fed from the left, causing the router bit to force the work against the fence instead of away from it.

4. A ball point cuts very poorly on the end. If the drill-press table is tilted to bring the side of the cutter to bear, you'll get a clean groove.

5. Once the collet is driven into the cone chuck it cannot be withdrawn. It should be made with a shoulder by which it can be pried out.

Hangers Enable You to Add Shelves as Required

HERE'S a convenient way of adding shelf space in your basement or shop as your needs increase. New hangers offered by the Dekor Company, of Philadelphia, make it possible to start from the ceiling and build down. Each hanger is heavy wire, formed in a U-shape with hooks at the top and large eyes at each lower corner. Called Add-A-Pair Shelf Hangers®, they sell for 75 cents a pair. Photo shows how they're used.



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Be Your Own Blacksmith

The equipment doesn't cost much, and a beginner can soon develop enough skill to make many useful articles.

By John P. Arnold

THE ability to work iron and steel at a forge and anvil is a handy asset to any craftsman—whether for such practical tasks as general repair work and making machinery and tools or for reproducing wrought-iron work and antique hardware.

What's more, it's a handicraft that requires no expensive equipment. And the fundamental techniques can readily be picked up with a little practice.

Only two pieces of special equipment are necessary: a forge to heat the metal in and an anvil to shape it on. The various hand tools that you need—hammers, tongs, cold chisels—are ordinary shop equipment. You can even make many of them yourself.

The forge need be no more elaborate than a portable "pan" model, as in a photo on the facing page, which you can buy for less than $20. Another approach is to make your own forge of brick and mortar, using manufactured parts only for the firebox mechanism—called the tuyere—and blower.

Since cast iron is the only common metal that won't burn out in the intense heat of a forge fire—up to 2,500 deg. F.—the fire bowl and tuyere should be made of fairly heavy castings. The surrounding surfaces may be of stone or of flat metal pieces salvaged from an old coal stove. Clay can be used to fill the spaces between the bowl and the table; heat from the forge will bake it hard. You can buy either a hand-operated or motor-driven blower, or make your own from a discarded vacuum cleaner.

A deep, clean, compact fire is necessary, as free of impurities as possible. Use a sulphur-free bituminous coal. The fire is started by lighting a wad of newspapers, adding shavings, and raking coal over this as the blower is operated. The coals are converted into coke as the gases are burned off. Work should be heated only in the coke part of the fire.

A 75-lb. anvil is about the minimum size for general work. This costs about $25 new, but you may be able to buy a second-hand one for much less. It should be mounted firmly at a convenient height. For most work, you need only two hammers: a 2-lb. ball-peen hammer and a small sledge or flat-faced hammer. While a good assortment of tongs to hold the heated metal is convenient, a single pair of flat-jawed tongs can be adapted to various sizes and shapes by heating and reshaping the jaws. Punches, stamps, and swages may be acquired or made as needed.

Most forging techniques are extremely simple and easy to learn. By practicing the

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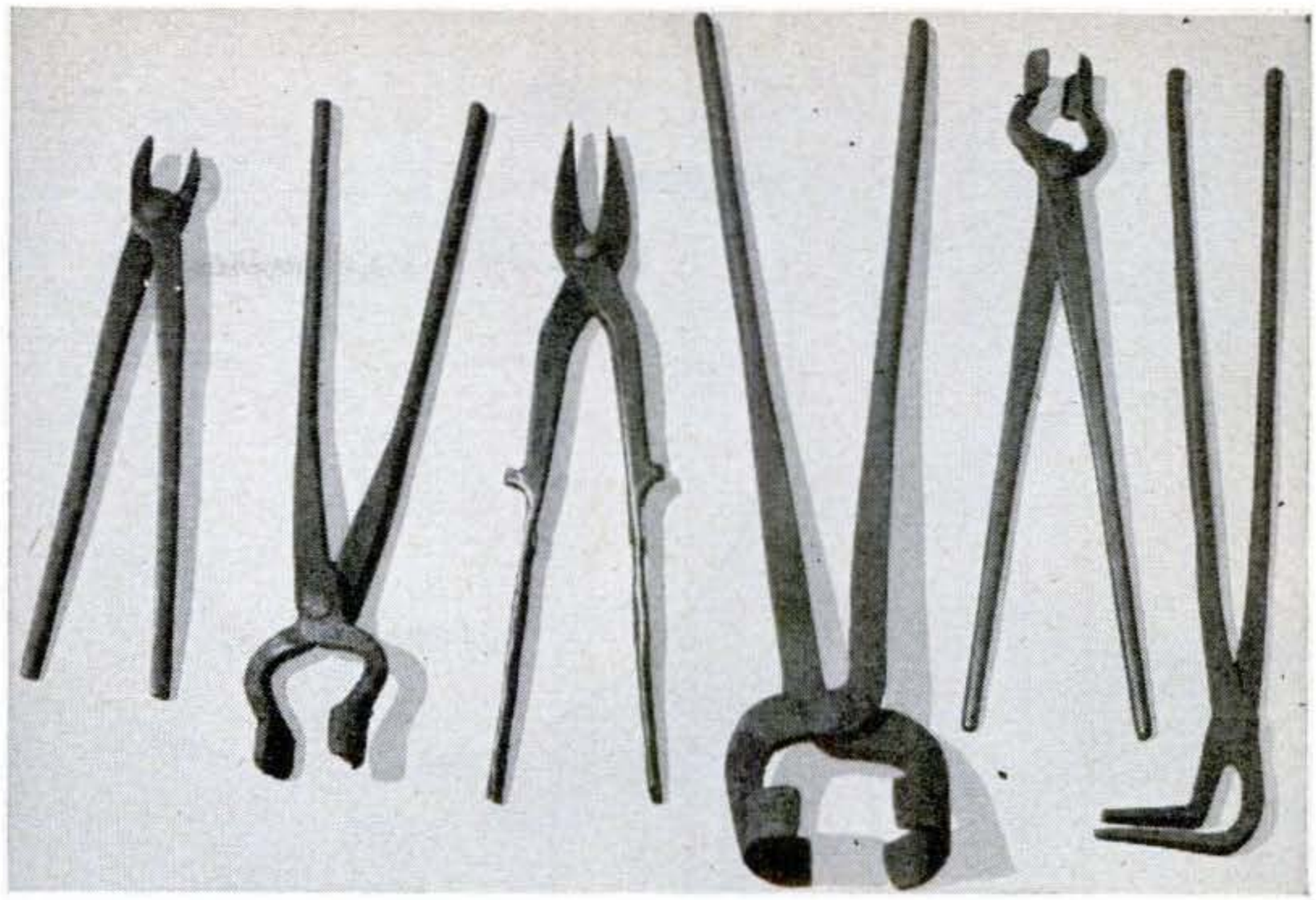
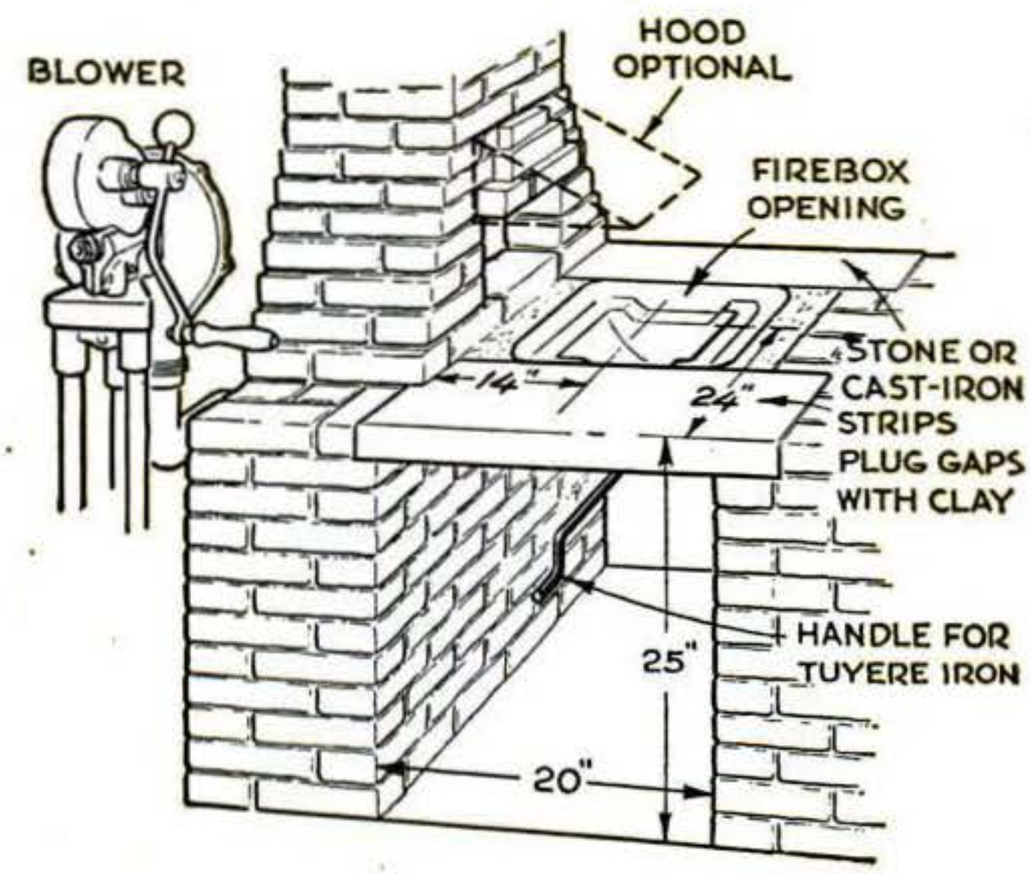
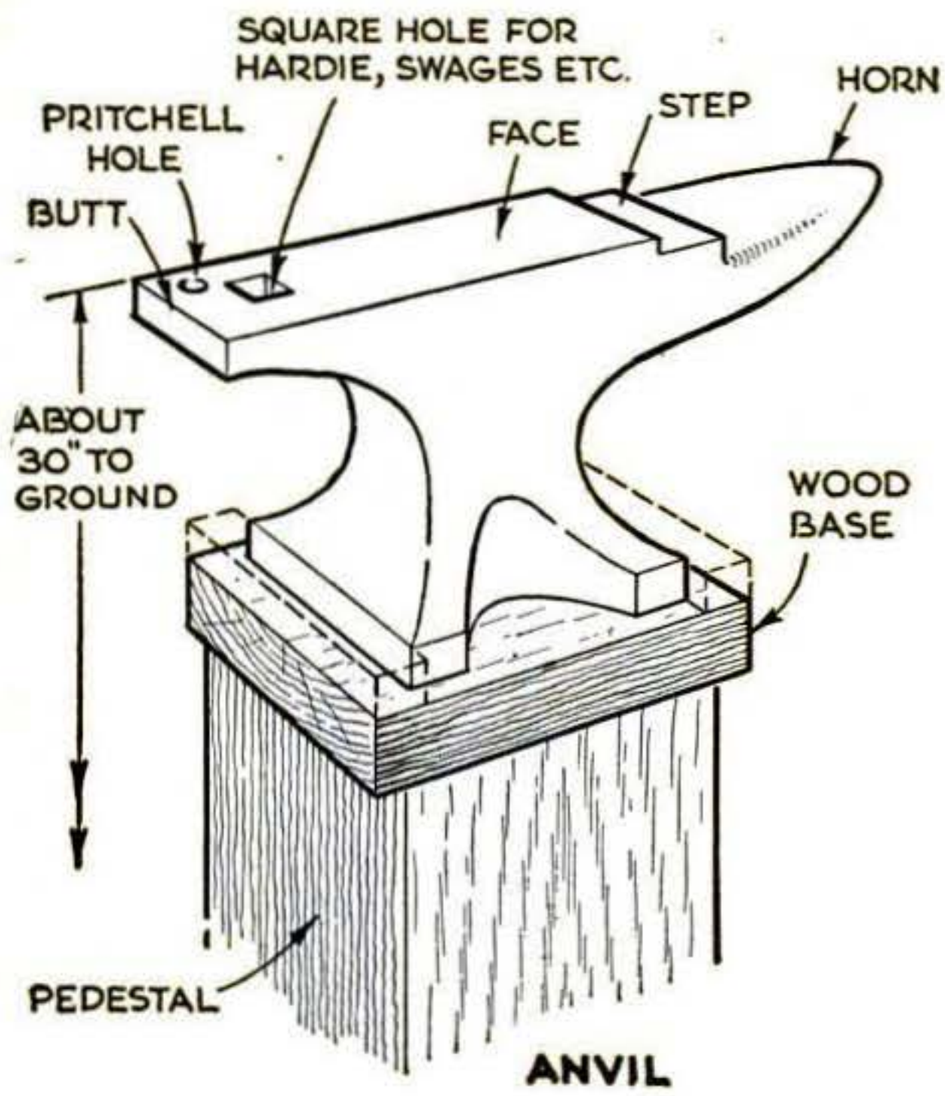


The forge can be a portable "pan" type (left) or a permanent installation (right), built around a few manufactured parts. Above is an assortment of tongs for handling stock.



BRICK FORGE



ANVIL

following, you will soon develop enough skill to make many useful articles:

Bending, twisting: Acute and right angles are made by heating the iron to a bright red at the point of bending and then hammering it to shape over the edge of the anvil. A light punch mark is enough to mark the bending point; marking it with a heavy chisel cut will weaken the metal. Slow curves and obtuse angles are sometimes bent cold in a vise, but it is better practice to heat the iron for these also. Decorative twists in ½" stock or smaller, however, can be made by holding one end of the cold metal in a vise and twisting it with a wrench; it's hard for a beginner to do this with hot iron, since the working section must be evenly heated to twist uniformly.

Drawing (tapering or making a section longer and thinner): The heated iron is pounded over the horn of the anvil, which thins it out at the point of contact. The piece is moved back and forth, and turned over with each hammer blow, until the desired section is obtained. The metal is then trued on the face of the anvil. If a section of square stock is to be finished round, the corners are first flattened to an octagonal shape and then hammered round by eye.

Upsetting (making a section shorter and

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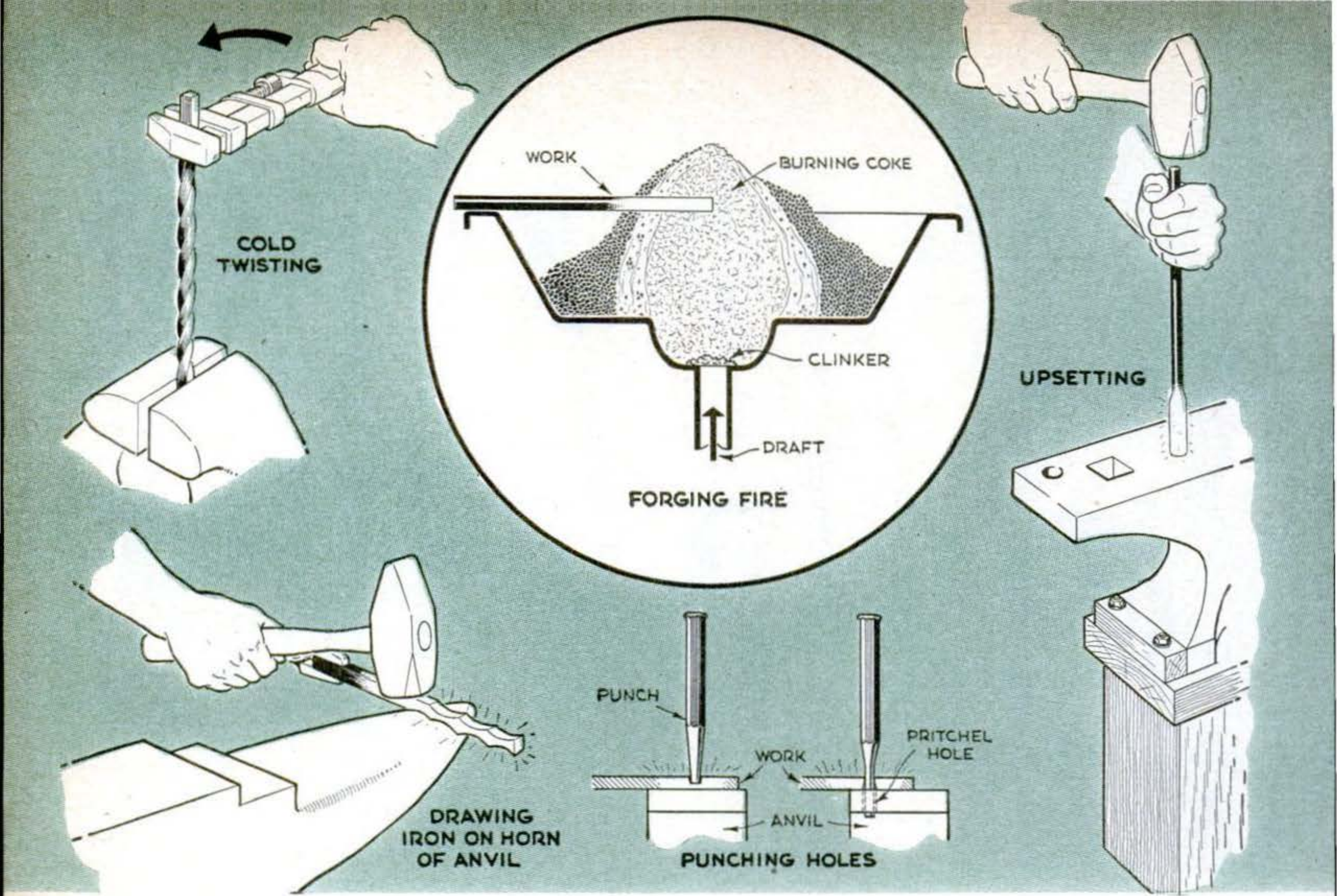
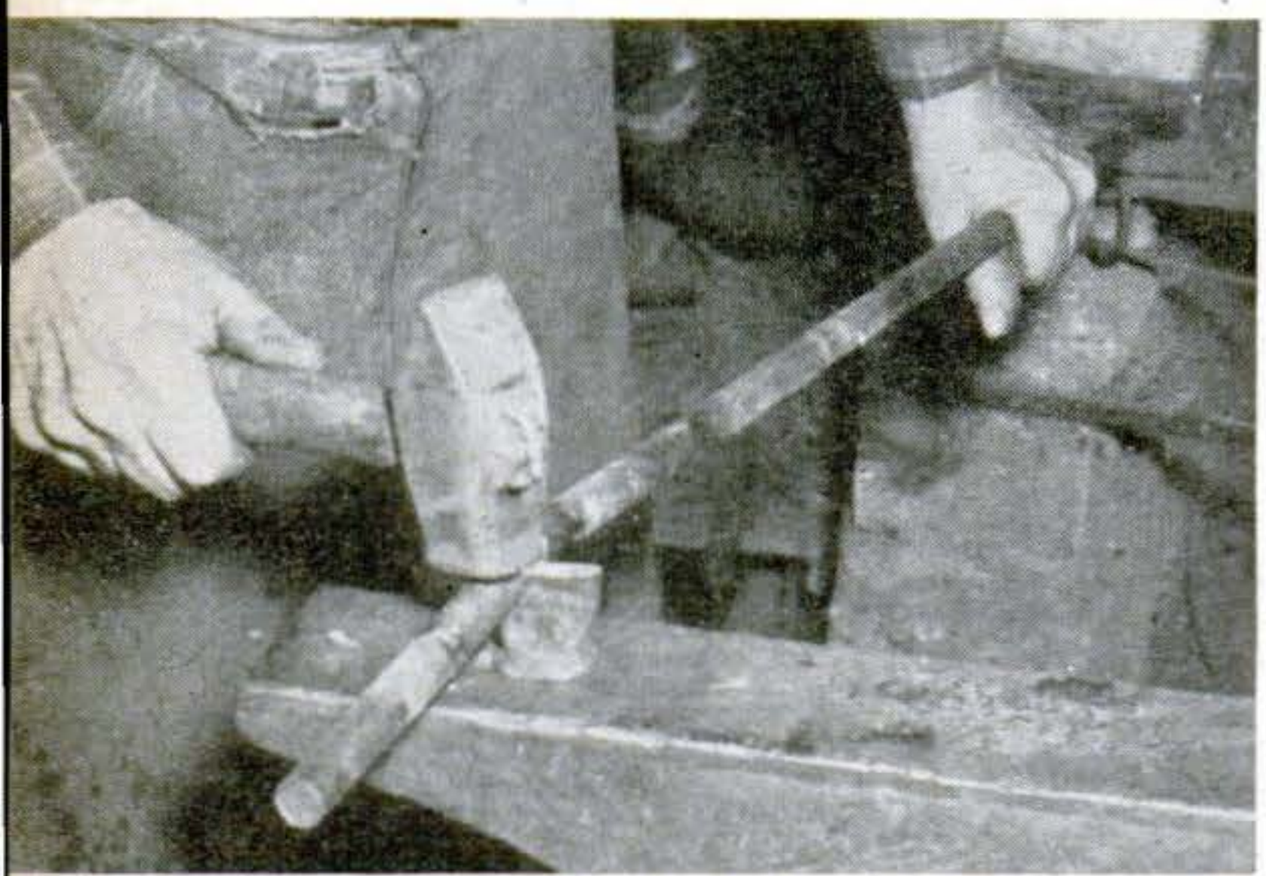
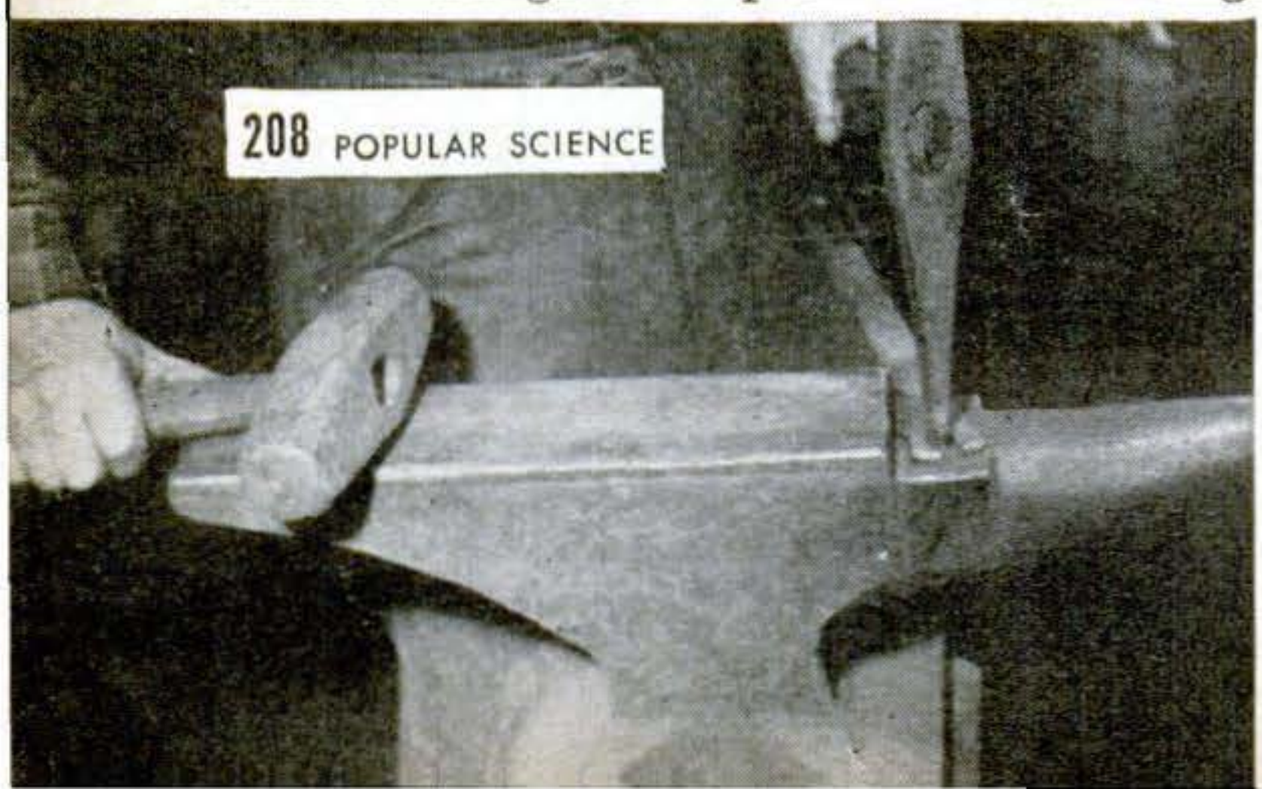




Stock is cut with short chisel held in place by tang that fits into square hole of anvil. Rod here is long enough to hold without tongs.

For splitting flat iron (below), a long chisel with handle is used. Here the weight of the chisel is enough to keep stock from bouncing.



thicker): This is done by driving the metal back on itself with heavy hammer blows; light strokes won't do it. The working temperature—a white heat—must be confined to the portion of the iron to be thickened. If the heat spreads, the metal should be quenched in a tub of water and reheated. Short pieces can be butted against the face of the anvil; longer ones can be "rammed" by swinging them against the side.

Punching, splitting: The white-hot metal is laid on the face of the anvil, and a flat-faced punch is driven half way through it by a hammer blow. The iron is then turned over and centered over the pritchel hole. Striking it with a punch on the reverse side will then drive a pellet of iron clear through the piece. If it's done right, the edge won't be ragged. Hot iron can be split with cold chisels or special hammers, and decorative patterns can be worked on the surface with chisels, punches, and stamps.

Welding: This takes considerable skill and practice. Wrought iron and hot-rolled mild steel work best for a beginner. The welding temperature is a high white heat at which the iron appears to merge with the flame of the forge. If the iron emits white sparks, it is too hot; if there is excessive

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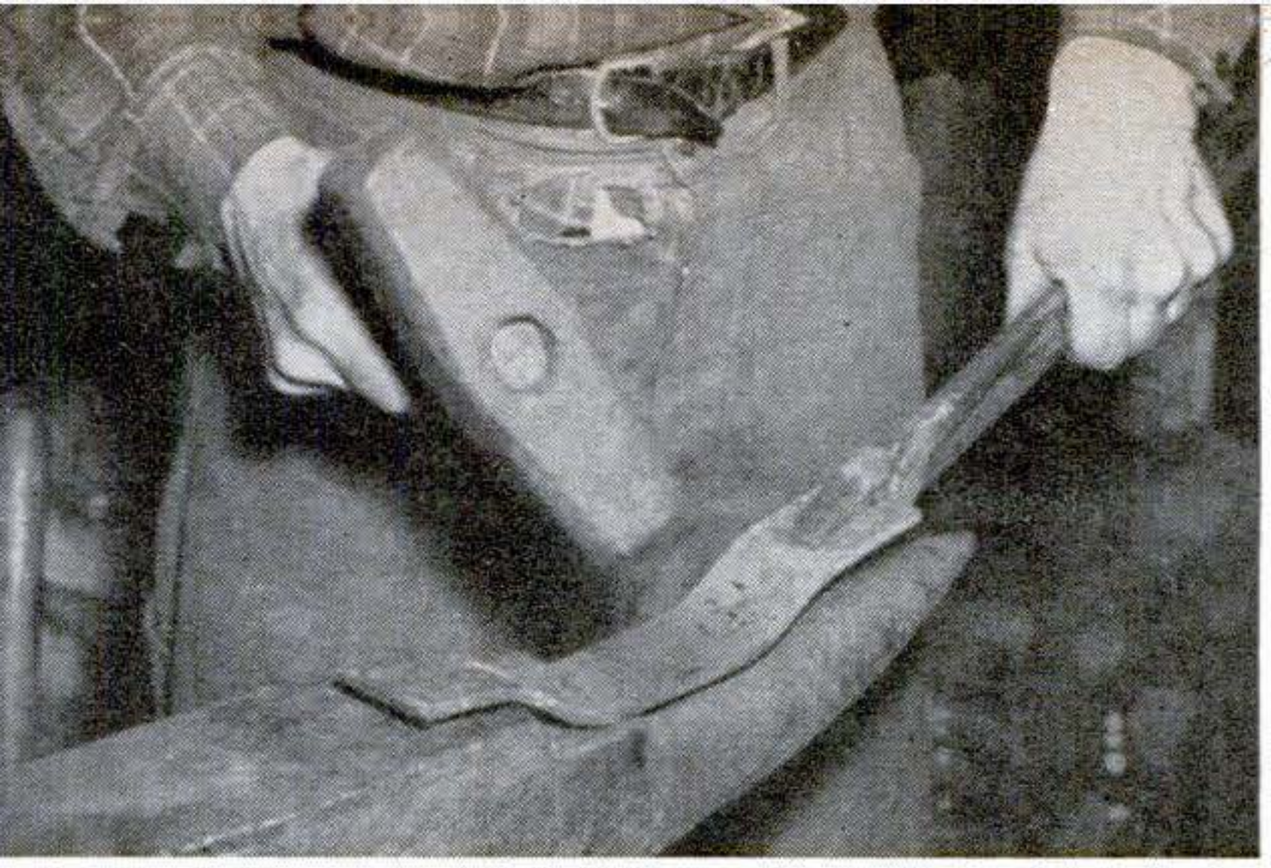


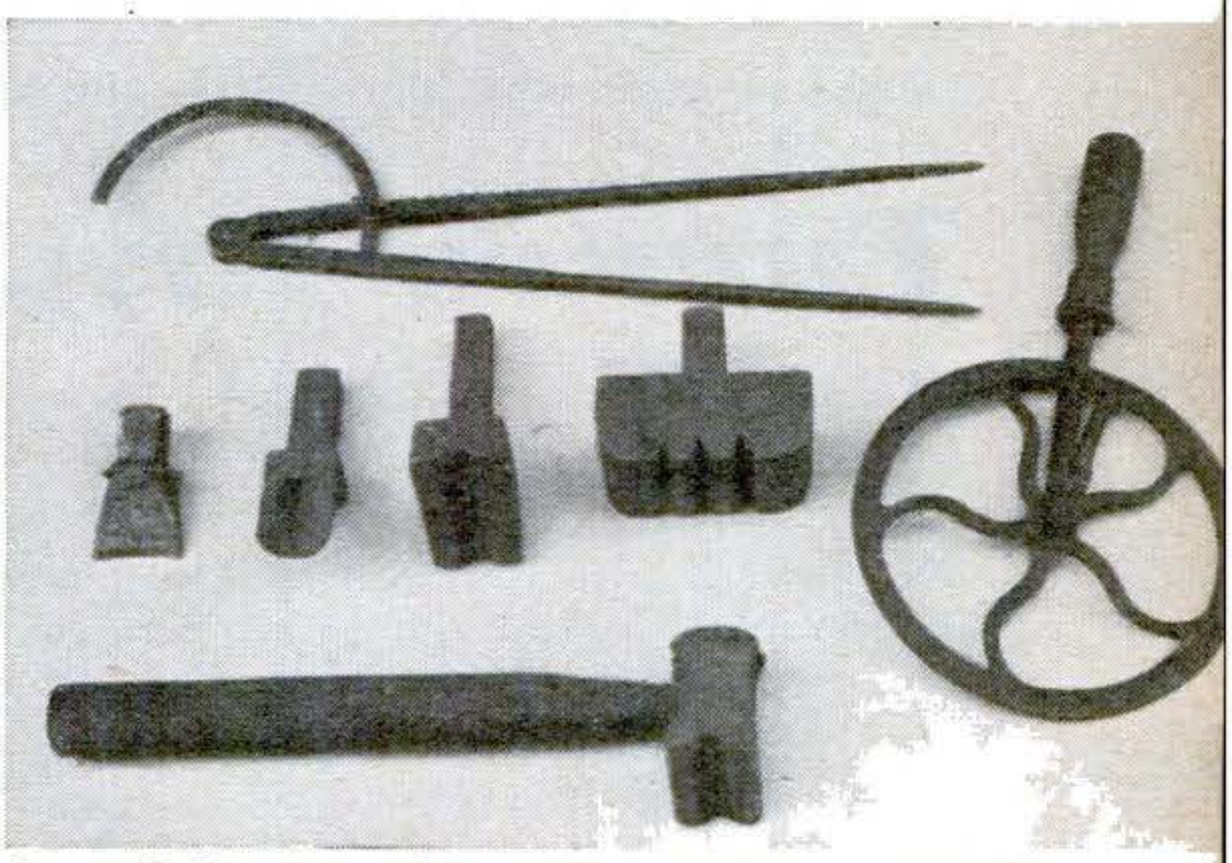
Iron can be hammered to any shape against varying contours of different portions of anvil. Reheating may be necessary to keep it workable.

Holes of any size and shape are made in hot iron with flat-faced punches. Frequent quenching will keep heat from annealing a punch.

scaling, and the pieces will not adhere at the first hammer blow, they're too cold.

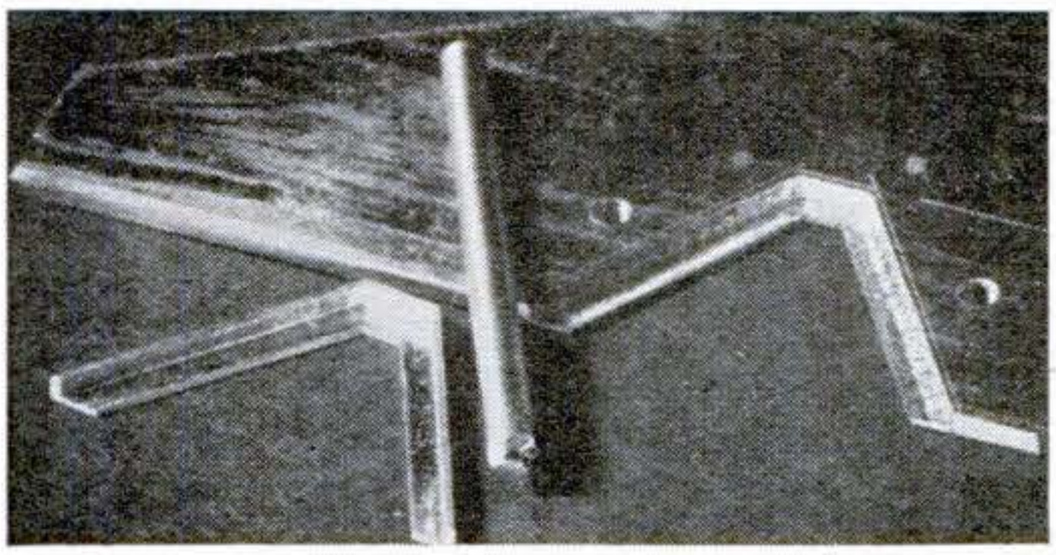
Welding is sometimes facilitated by using various commercial fluxes to prevent the formation of oxides. When the iron to be joined reaches a yellow heat, the flux is sprinkled over its surface. Fluxes are not needed, though, if the fire and metal are free of impurities and the correct heat is obtained.

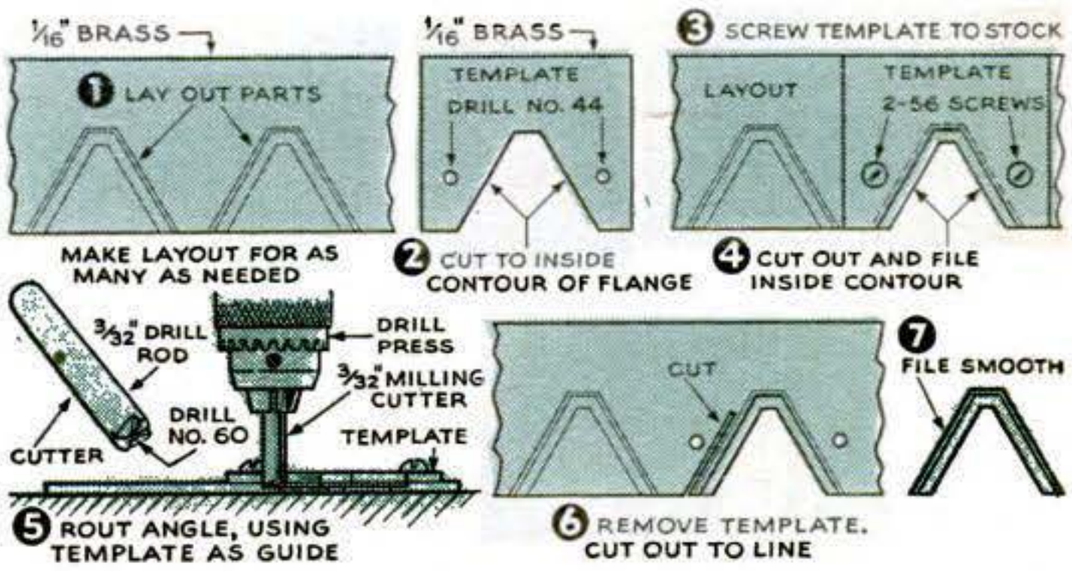
Joining surfaces should be slightly convex, so that the pieces first come into contact in the center of the joint. Hammering them together then squeezes out air, scale, and impurities that might weaken the joint. If the pieces do not adhere at the first hammer stroke, they should be reheated. END



Special blacksmith's tools: compass, straight and round hardies (left center), swages, traverse to measure circumferences, swage hammer.

Angle-Iron Model Details Milled From Brass





ONE of the toughest problems in building scale models of ships, bridges, and railroad structures is to reproduce angle-iron details. These add a lot if modelled as they really are. But because of the difficulty of obtaining and bending suitable stock, many modelmakers just skip the detail and use solid parts. I've found that for painstaking work in ¼" scale, it really pays to mill structural angle from 1/16" brass.

With a small milling cutter in the drill press, it's less work than you may think; and in the case of a repetitive detail like the brace shown above, pieces can be turned out in short order. Note in the drawing that the template guides the milling operation, which removes the necessary stock in a single pass, and the rest of the job is simply sawing and filing to the line.—*Herbert Pfister, Bronx, New York.*

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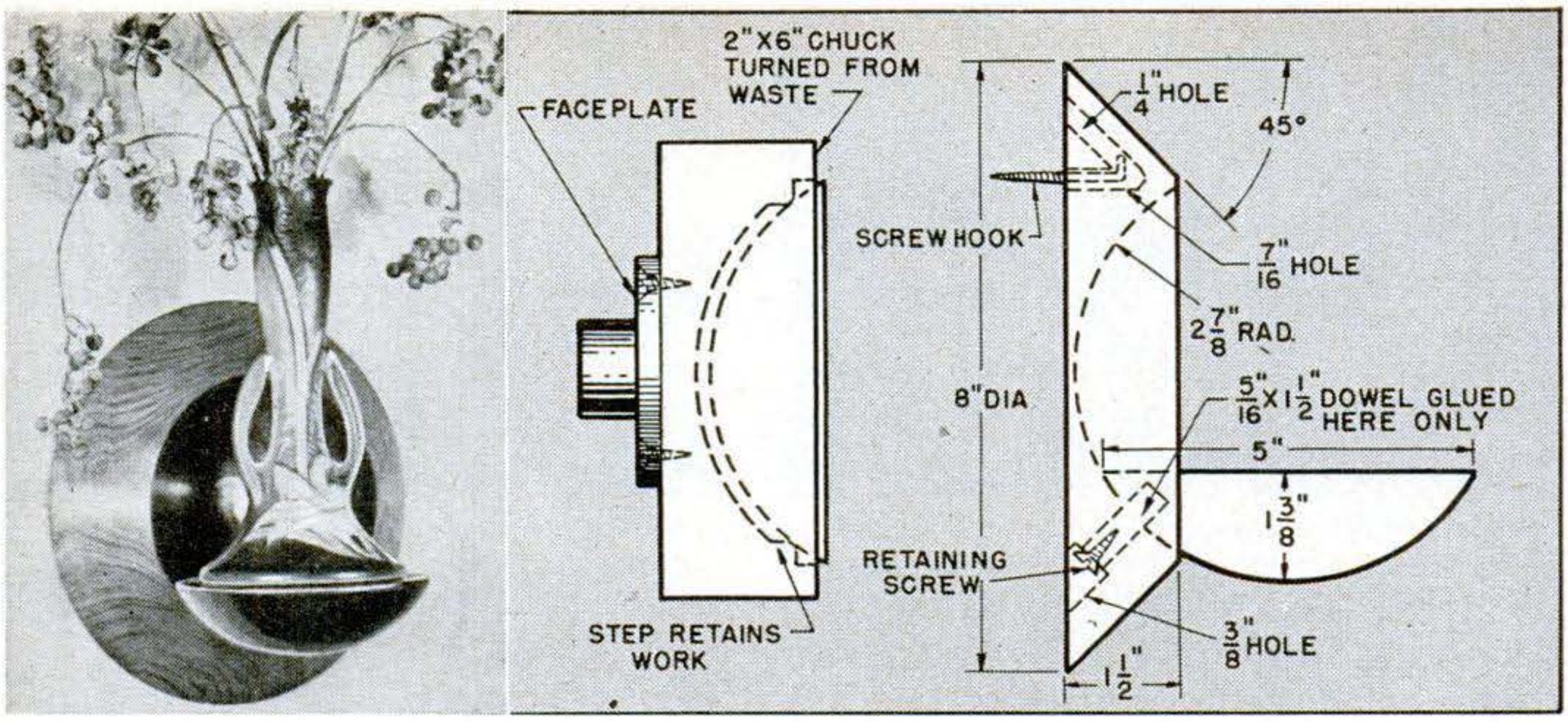


A dowel pivot attaches the shelf to the back. The holes for it must be drilled carefully.

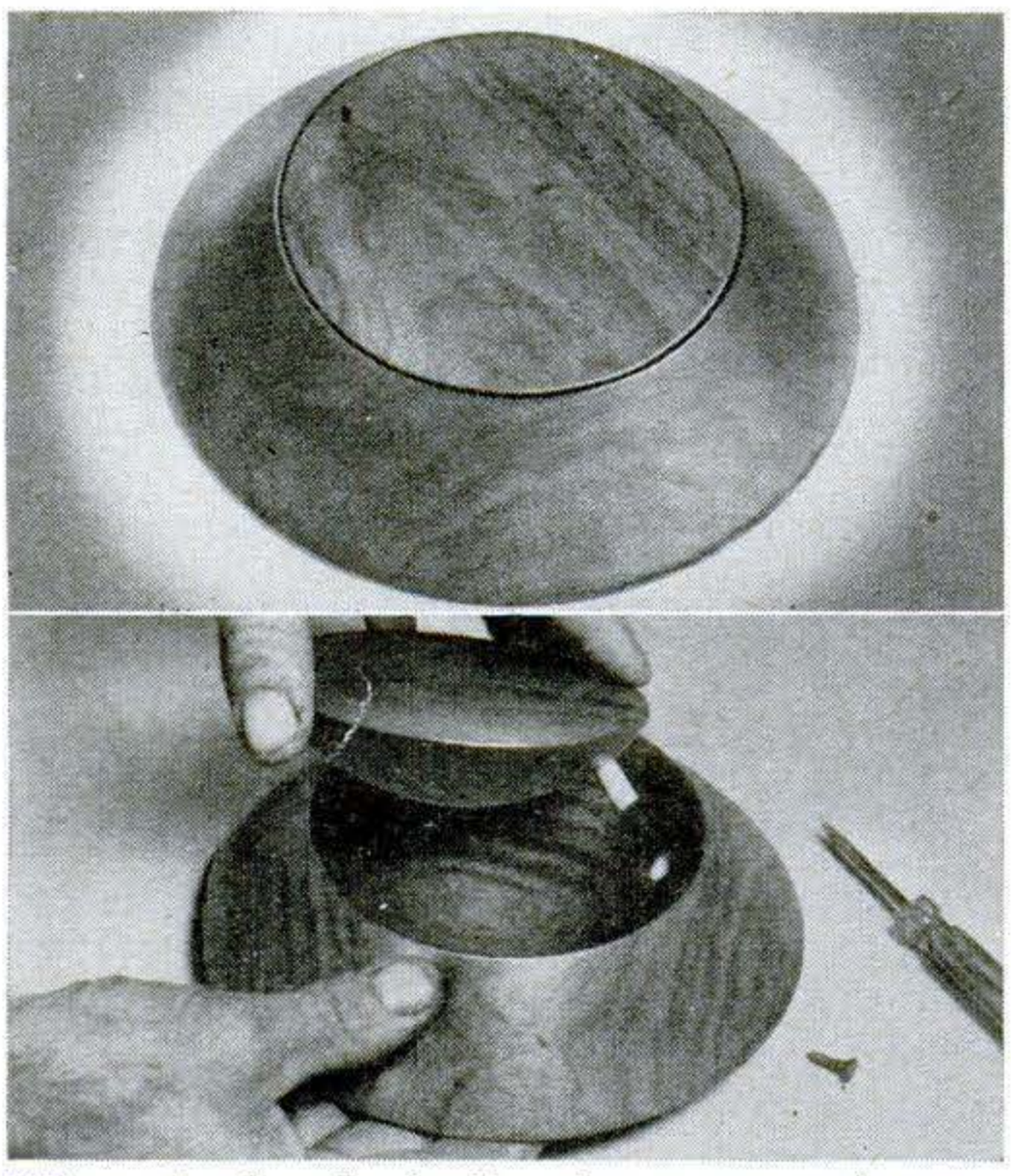
Turned Bracket Closes Up

THESE handsome wall brackets present a challenging lathe project. Each bracket consists of two parts, plus a pivot pin that allows you to turn the shelf snugly into the back member for storage or gift wrapping.

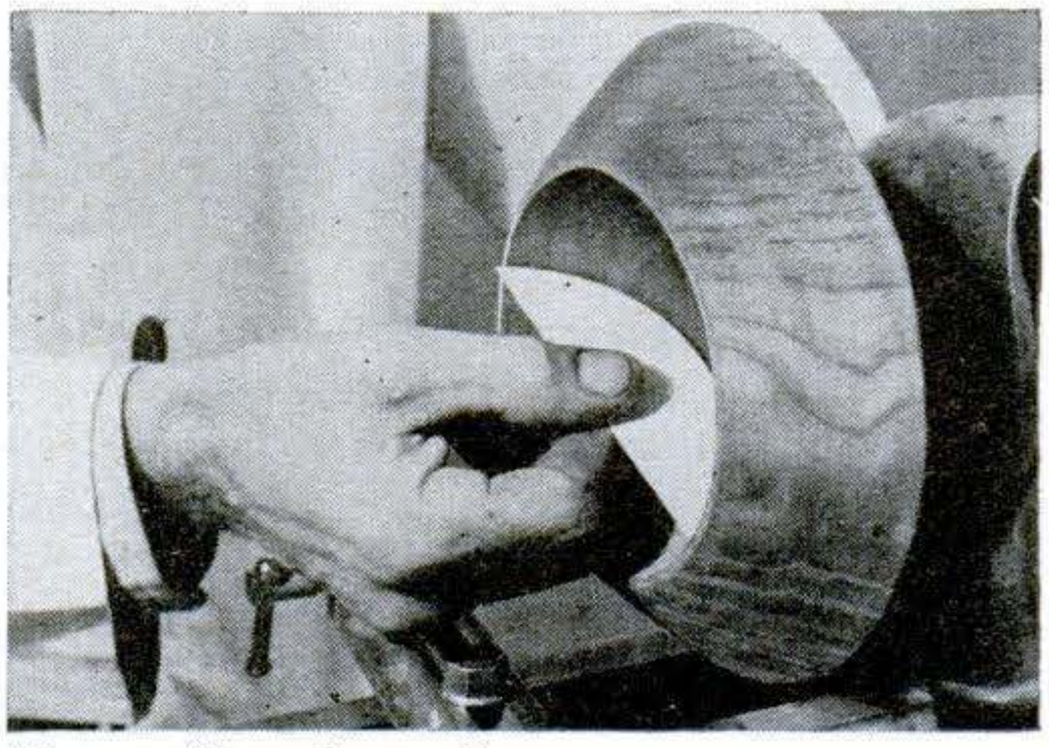
Start with two walnut blocks, one 1½″ by 8¼″ by 8¼″, the other 1½″ by 5″ by 5″. Bandsaw an 8″ disk from the larger, screw it to the lathe faceplate, and true and sand the surface. Then glue a piece of waste to the trued surface with paper between. When the glue has set, remount on the lathe by means of the waste. Turn as shown, using a cardboard template to assure accuracy. After sanding, give the surface a spun shellac finish. Finally, split off the waste and sand any roughness from the glue.

Use the same procedure for the shelf. After the convex surface has been given a shellac finish, remove the waste. It may now be necessary to cut down the flat surface so it'll be even with the rim of the hollowed part of the larger member. To do this, place a piece of waste on the faceplate and hollow it out as shown so the convex surface of the shelf is a light press fit.

Drill the dowel hole accurately in both parts. A jig is probably best for this. Before attaching a wall hanging, wax both parts.—*Benj. Nielsen, Aurora, Neb.*



When the bracket's closed, as seen at the top, the pivot dowel is hidden. In this position, it lends itself to easy packaging for mailing.



Use cardboard templates to assure accuracy so the concave and convex surfaces of the parts will mate closely when they're assembled.

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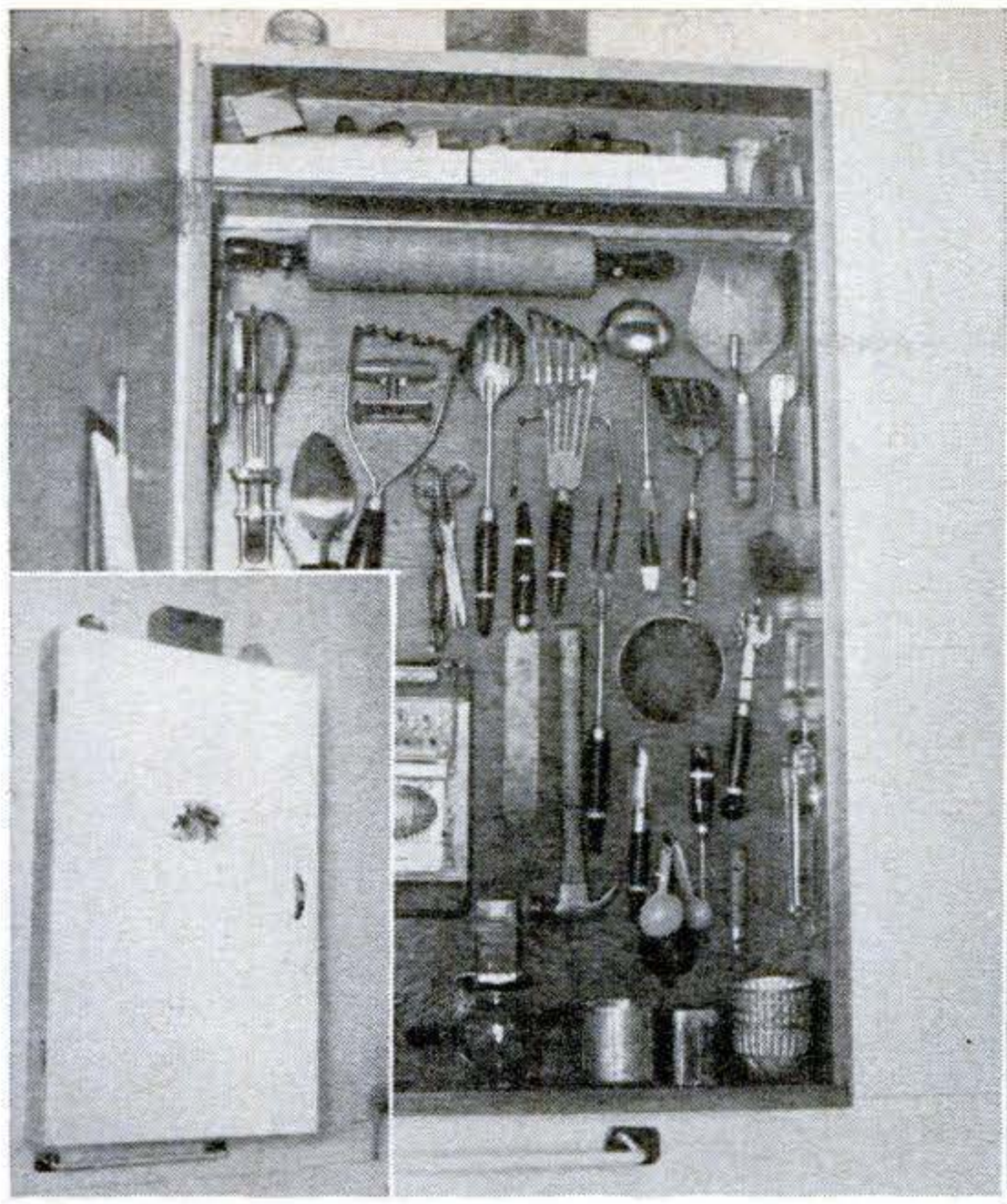
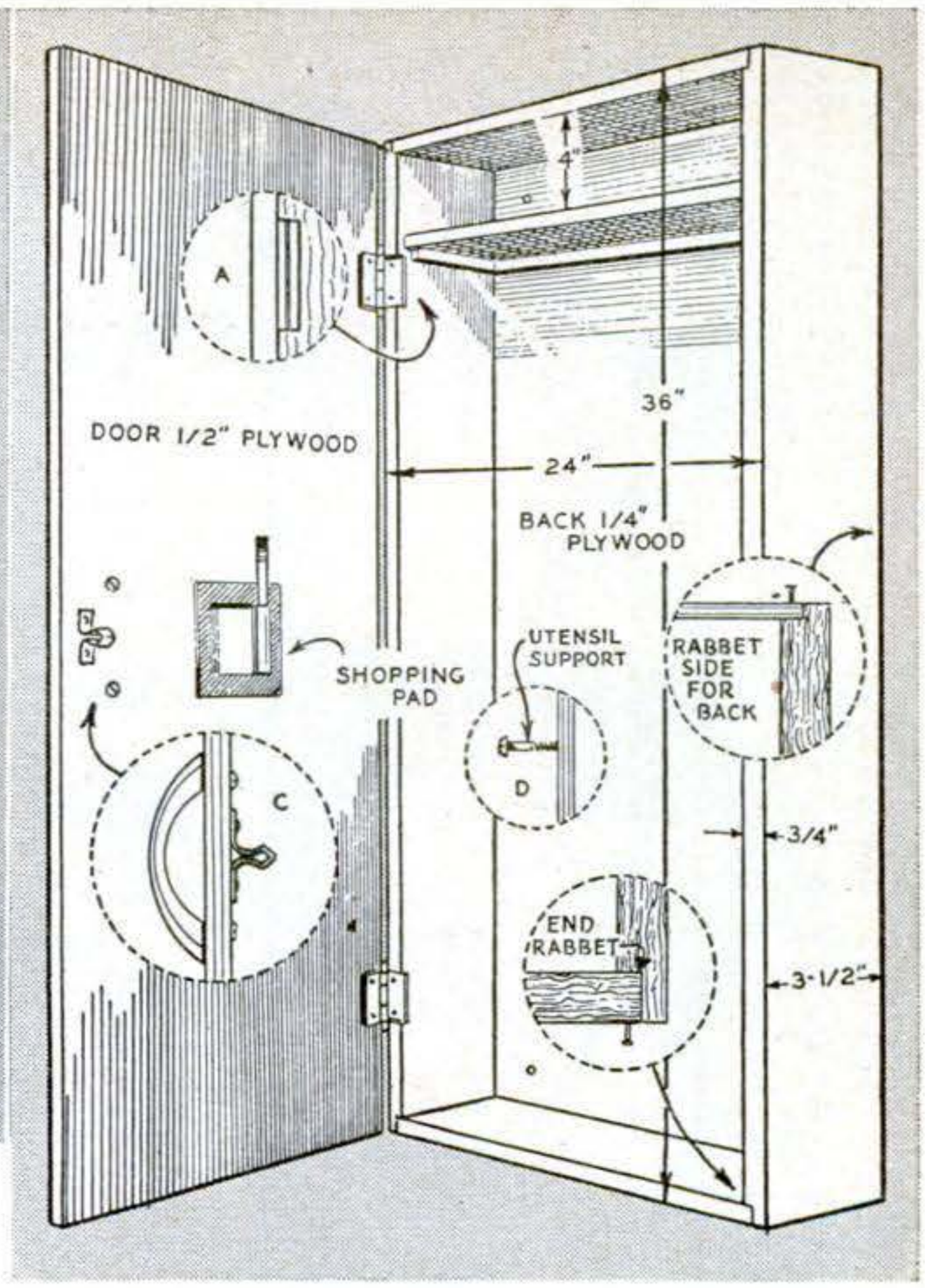




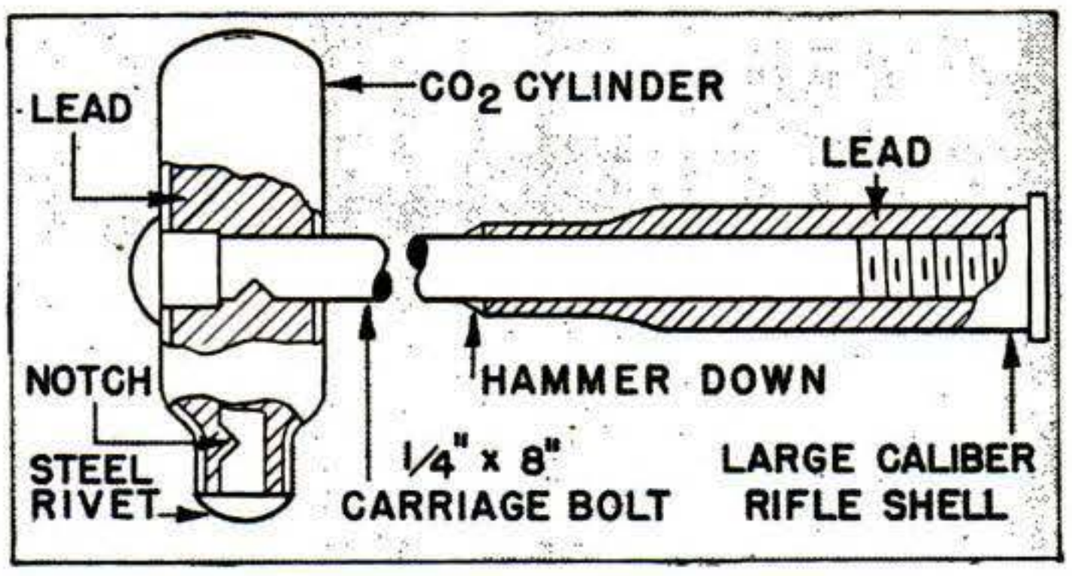
Kitchen Tools Kept in Cabinet

HERE'S the answer to the usual scramble through a drawer of kitchen utensils to find the one you want—hang them neatly in a cabinet. The project pictured here is 3½" by 24" by 36", holds 65 kitchen tools, and cost me less than $6 for materials.

Dimensions should suit your utensils and wall space. The construction is simple; I rabbeted the sides for the top, bottom, and back, but plain butt joints will do. The shelf, 4" from the top, rests on a cleat. This is handy for storing such items as matches and cookie cutters. I used roundhead wood screws on which to hang the utensils, although regular brackets for that purpose are available. You'll also find the shopping pad and pencil on the inside of the door a convenient addition to the cabinet.—*Harold Jackson, Kankakee, Ill.*

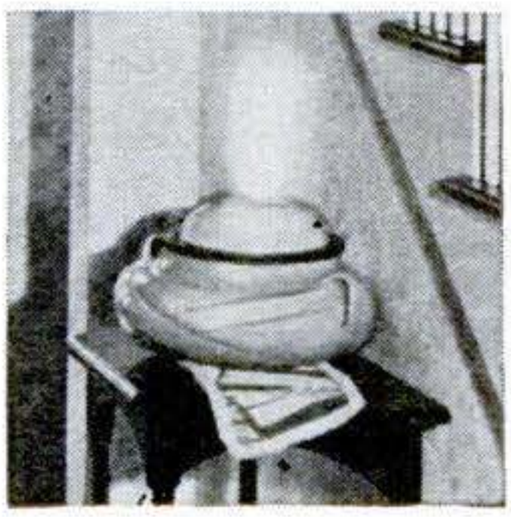
Modeler's Hammer Uses Carbon Dioxide Cylinder

THIS little hammer has two sizes of rounded hammering surfaces for work on models or other small jobs. Use a 3/16" drill to ream out the remainder of the perforated seal in the cylinder neck. Then drill a ¼" hole through the cylinder from side to side. Notch the carriage bolt as shown and shove it through the ¼" hole. Fill the cylinder with molten lead, but before the lead solidifies, insert the notched rivet in the neck. The notches keep the bolt and rivet from working loose. Molten lead also is poured into the shell after the threaded end of the bolt is inserted in it.



Humidifier for Winter Use

THE electric humidifier pictured here evaporates about 1½ pints of water per hour and is operated by a 115-volt AC motor. It is said to eliminate the dryness in heated rooms that sometimes causes loosening of furniture joints, drying and wearing of rug fibers, and the breaking of book bindings. Maker is Walton Laboratories, Irvington, N. J.



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Overhauling Old Clocks

If you have a taste for antiques, bring the old family timepiece down from the attic and try your hand at reconditioning the old timer.

By Carl J. Penther

ANTIQUE clocks seem to have a way with time. They count it off second by second and keep on doing it for years, decades, and centuries. Even when they appear to have worn out, their relatively uncomplicated mechanisms may respond to cleaning and simple repairs with many additional years of service. Shelf and mantel clocks—unless badly damaged—probably can be restored to useful life by a few adjustments.

The chances are you won't have much success with clocks of the earliest American make, for most of these were one-of-a-kind handmade affairs with wooden movements. They fall roughly into the first period of American clockmaking, which extended from Colonial times to about 1800.

English and Dutch clockmakers who emigrated at this time brought their hand tools with them and made individual timepieces as they received commissions. Clockmakers were few, however, so many carpenters turned their skills to constructing delicate pinions, bearings and escapements. This may largely account for the preponderance of wooden movements.

The years from 1800 to 1860 constitute the second period of American clockmaking or, more precisely, manufacturing. Connecticut became famous at this time as the home of factories run by Eli Terry, Seth Thomas, Silas Hoadley, and others. Mass production began early in the century and brass works and spring drives soon began to replace wooden clocks.

By the seventh decade of the 19th Century the tendency toward great variation in design became very pronounced. Starting with steeple clocks, they ran the gamut of fancy French cast statuary, marble, china, Victorian cases, and chiming mantel clocks.

When you purchase an old clock "as is" or in running condition, it will probably require refinishing as well as cleaning and oiling. Make sure the pendulum bob is removed or securely tied or, if it is weight-driven, that the weights are removed before moving the clock.

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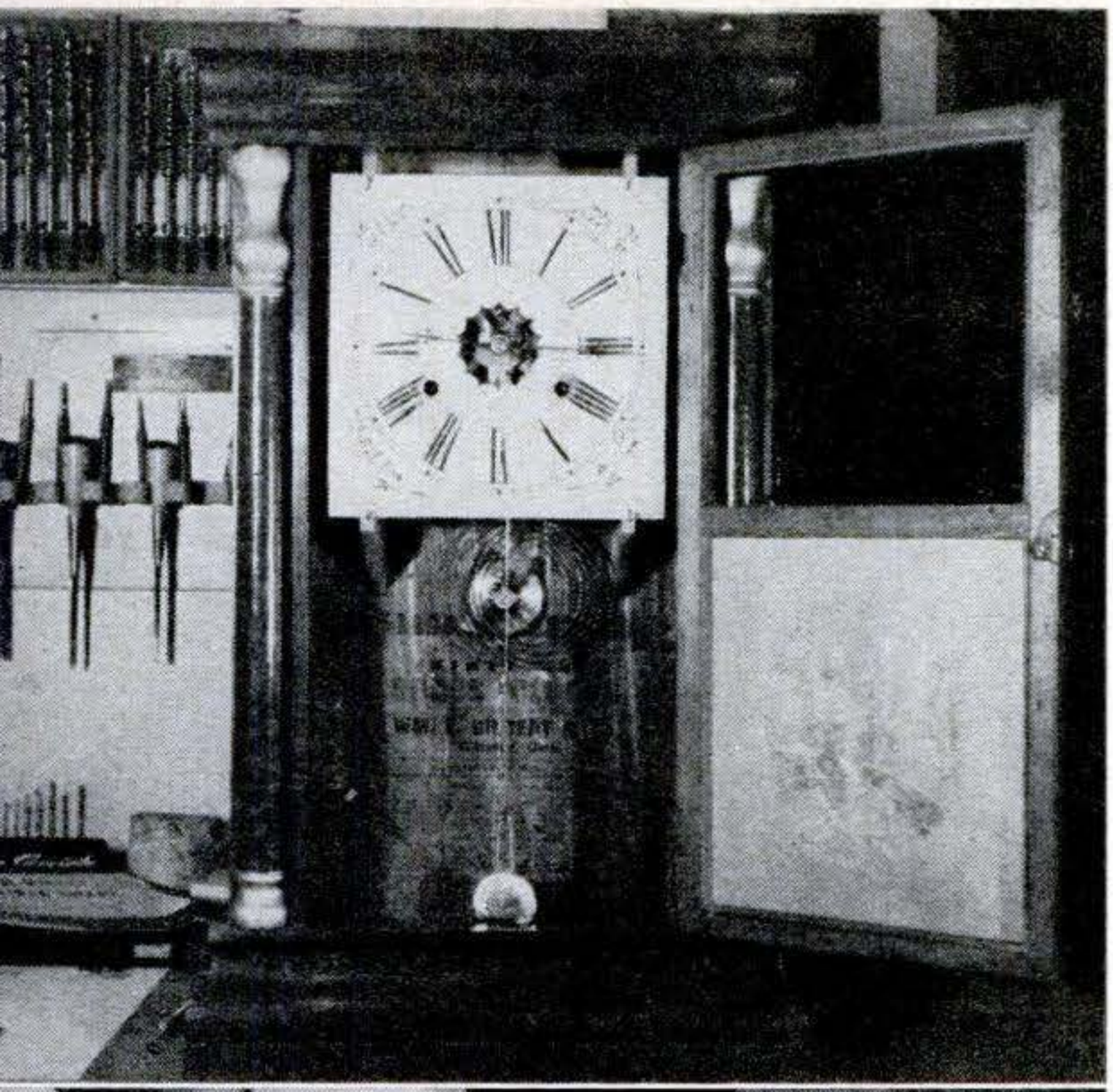
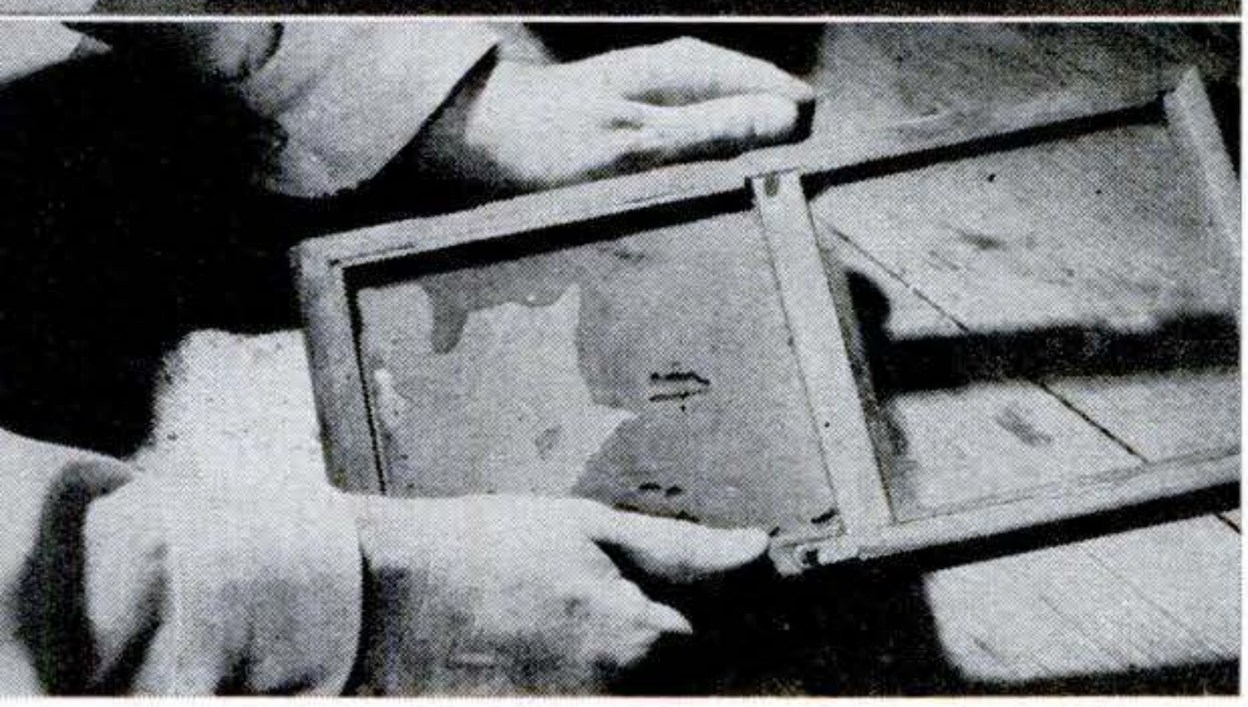
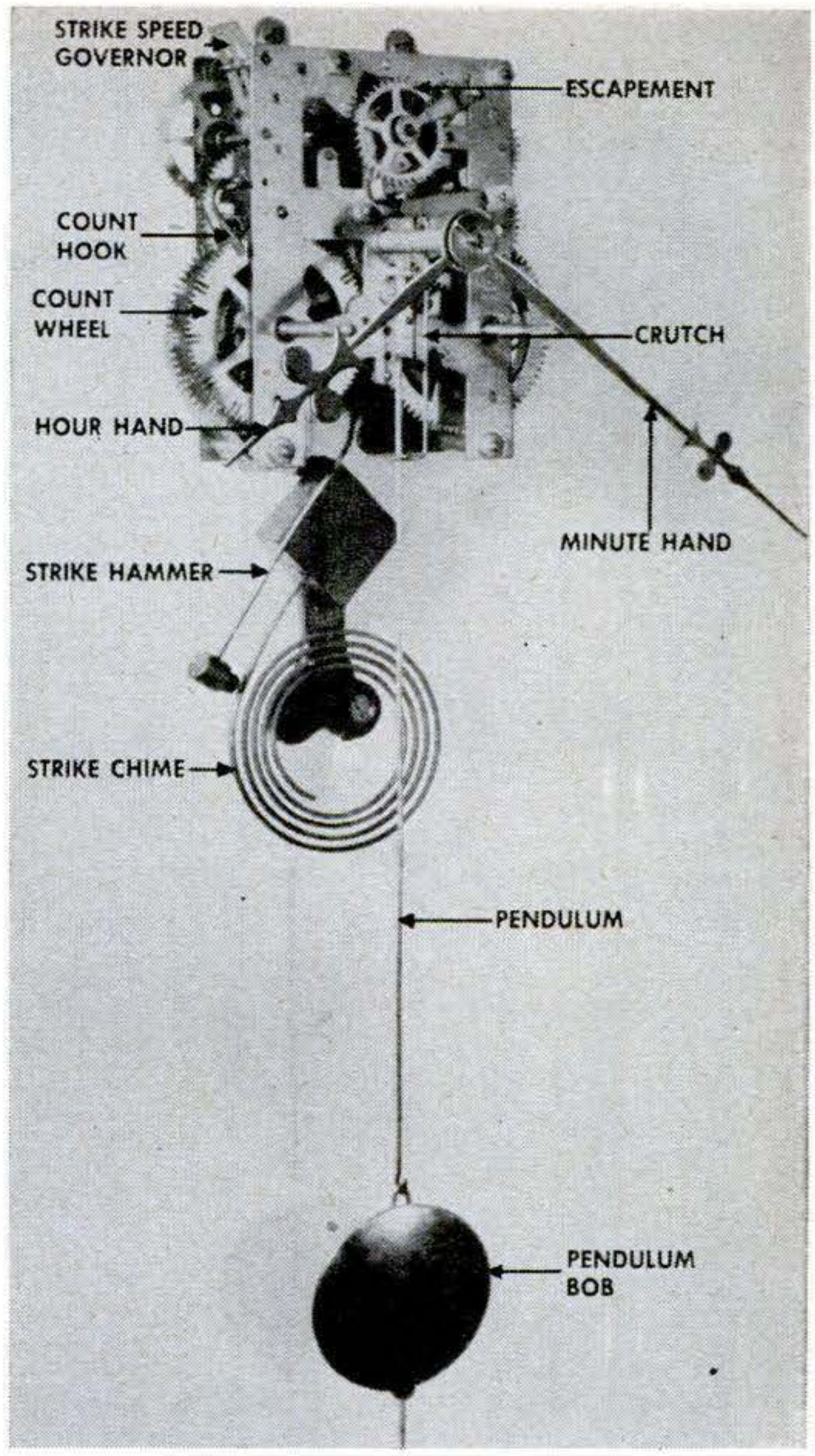




Thinned shellac is used to preserve the clock paper (top) and the painting on the glass. Flow it on the latter to avoid brushing.



Many of the parts referred to can be seen in this photo, but don't expect the parts of your clock to correspond in all details.

Two things that enhance the value of an old clock are the original painting on the lower glass, and the "clock paper," a sheet pasted on the inside giving manufacturer's instructions on how to level, set, and regulate the timepiece, and even where to oil it. In overhauling an authentic old clock the first step is to preserve what remains of the painting. Fix the painting by flowing on one or more coats of very thin white shellac on the back. Brush some on the clock paper, too. Glue down loose veneer so that it can be drying while you work on the clock movement.

Once you have disposed of these preliminaries, remove the hands and dial. This will expose the movement and permit removal of the pendulum. Withdraw the flat leaf spring at the top from its slotted support post and lower the pendulum through the crutch.

Take the movement out of the case. If it is spring-driven, run down the time and strike springs. To do this, move aside the flat keeper spring from the shaft of the pallet anchor and raise the anchor. Hold the spring to keep it from unwinding at top speed. To unwind the strike mechanism, lift the count hook by raising the trip wire that hangs vertically near the pendulum.

Before you go any further, inspect the pivots and bearings carefully—especially those of the escapement and pallets. If you don't find excessive clearance or elongation of the pivot holes, it is possible that the movement only needs cleaning and oiling. Apply a drop or two of gasoline to each pivot and wind or weight the clock enough to run a short time.

When the gasoline has had a chance to work in, wipe off the dirt from around the pivots. Repeat these steps until the bear-

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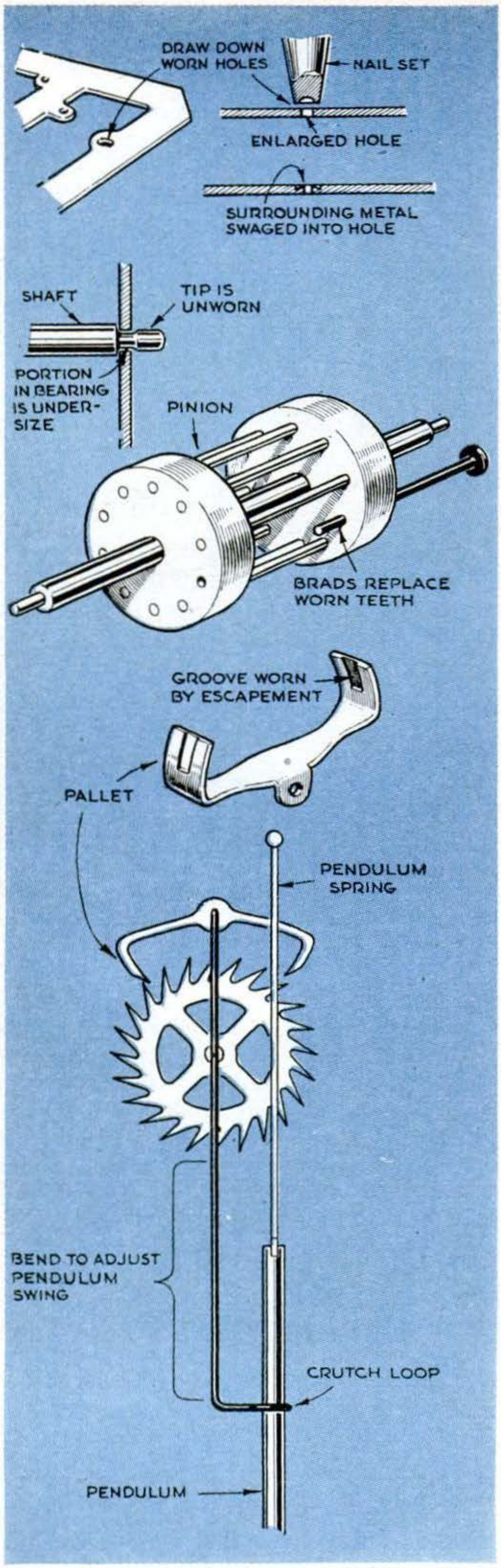

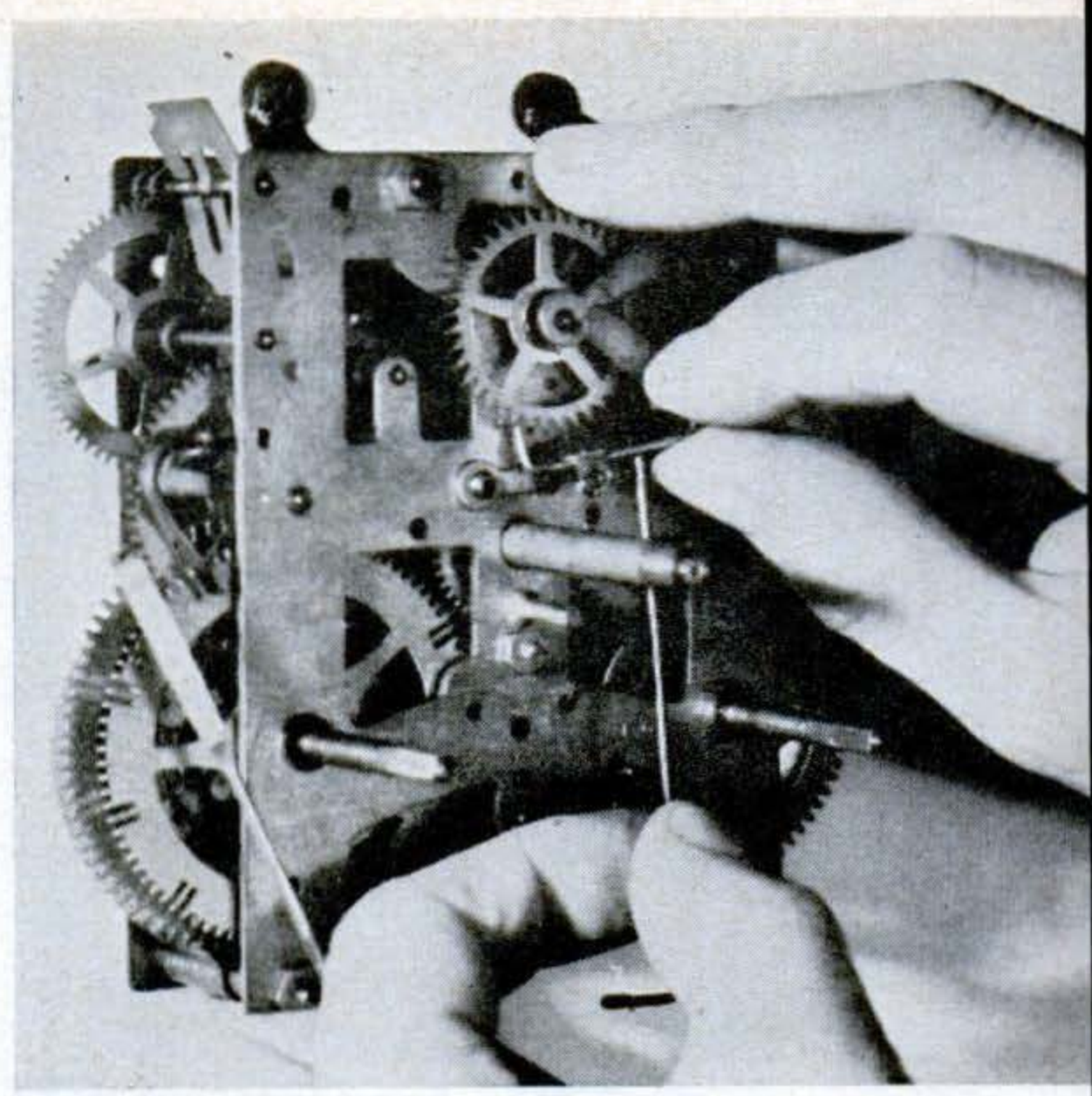

Removing the crutch and anchor. These govern the pendulum and escape wheel respectively and are therefore among the most critical parts.

ings appear to be reasonably clean. A drop or two of fine clock oil is then applied to the pivots, pallets, and the crutch loop. Let the clock run for a day, wipe off the excess oil, give each bearing another tiny drop and the movement is ready to return to its case. Be sure to use genuine clock oil, not light machine oil of any kind. You can probably get some clock oil from your neighborhood jeweler.

If your initial inspection of the pivot holes has shown some of them to be badly worn, the movement will have to be completely disassembled. Study the movement closely and mark each piece (a sharp needle is good for this) to identify its location. A key number on each gear and its pivot hole will tell you where to put it back.

With the springs unwound, withdraw the wedges from the corner spacer posts as necessary, and lift off the front plate. The various gears and shafts may now be unmeshed and removed from the back plate.

Using an old toothbrush dipped in gasoline, scrub the shafts, gears, and plates. Clean out all pivot holes with a round toothpick. Reduce any that are enlarged by placing the cupped tip of a nail set symmetrically about the hole and striking the head with a hammer. The proper diameter for the nail-set cup is about a third or a half larger than the pivot hole.

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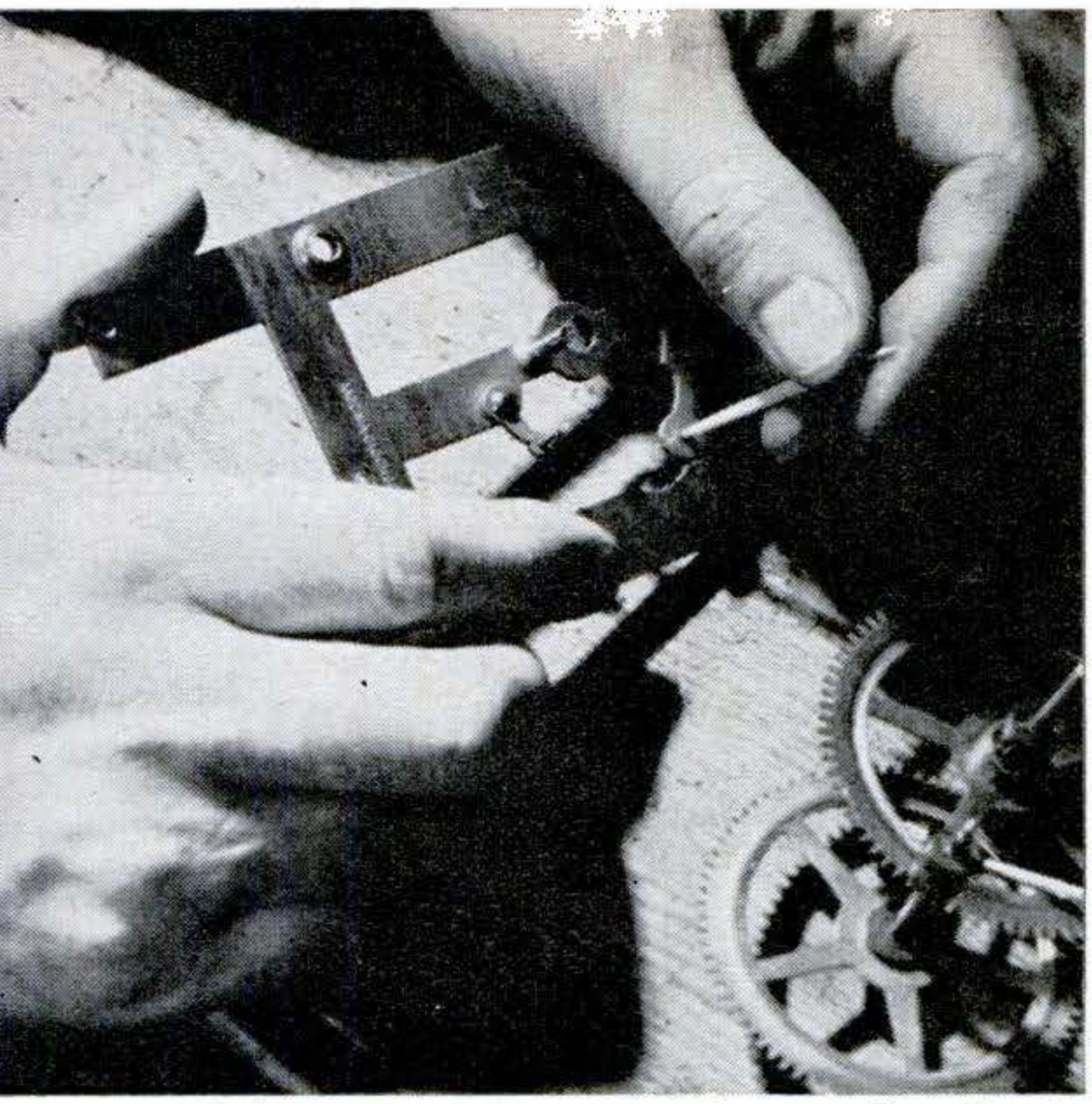
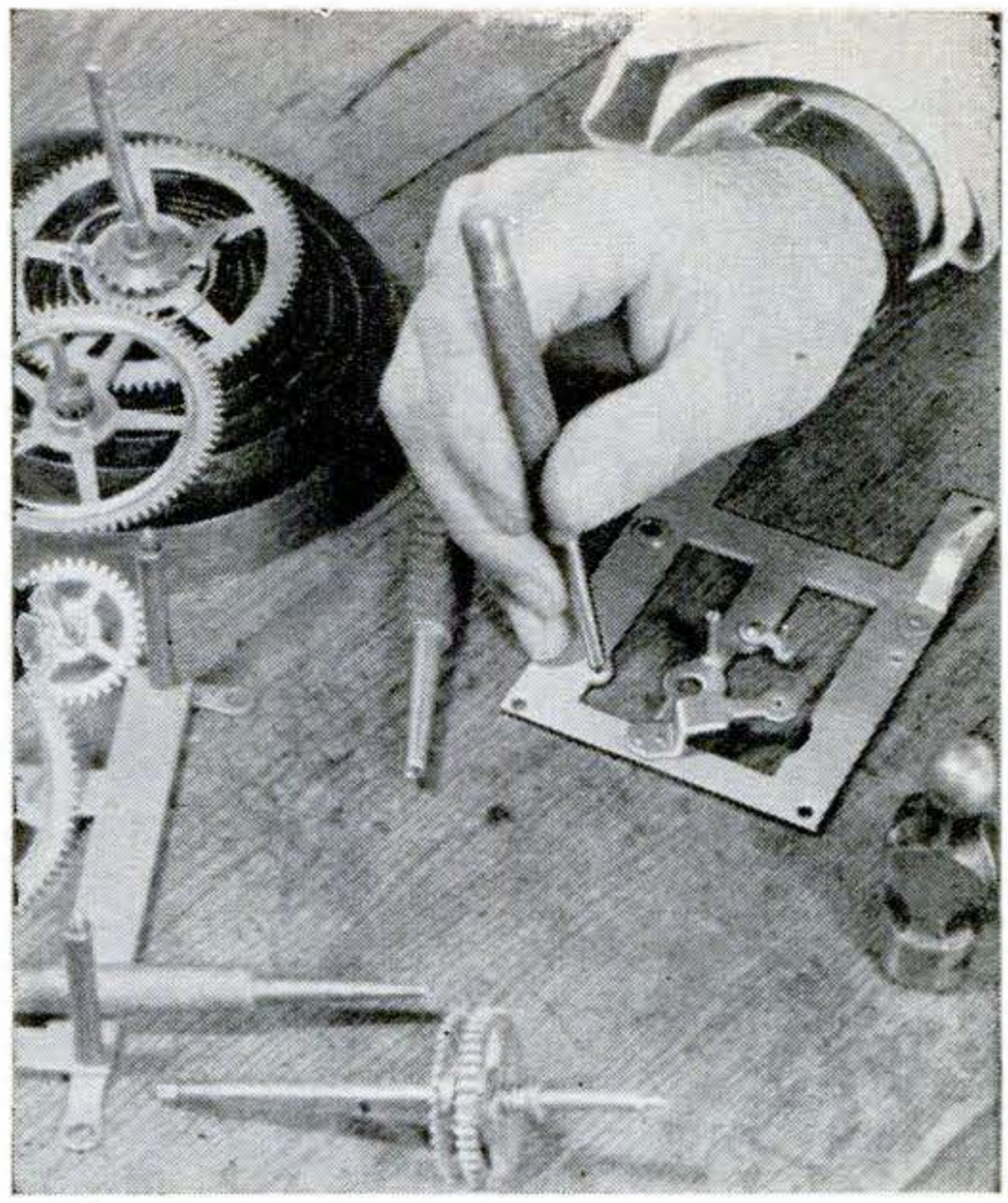


Cleaning out a bearing with a round toothpick. It is important that there be no roughness at the bearings to increase friction and wear.



A sharply cupped nail set is used to correct enlarged or elongated pivot holes. The nail set swages the metal to reduce hole diameter.

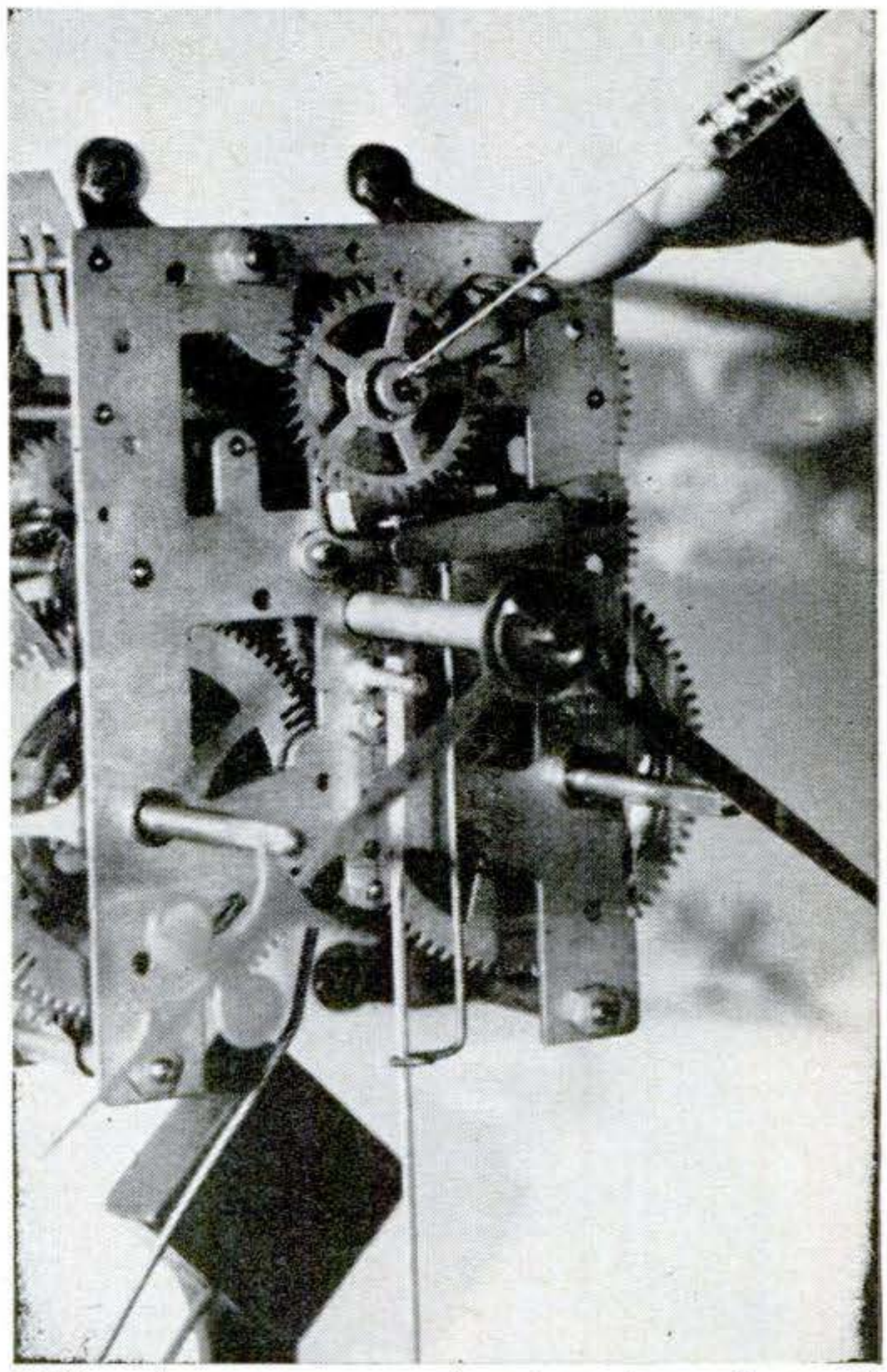
By careful work it is possible to decrease the diameter just enough to provide a satisfactory fit for the pivot, but if it is made too small it can be enlarged with a round darning needle. One important fact to bear in mind is that the bearing section of the shaft is usually worn to a smaller diameter than the tip.

Sometimes the pallets are badly grooved from rubbing the escapement teeth and must be honed and polished smooth again. Use a fine oil stone for roughing and an Arkansas honing stone for polishing.

Other parts that might be worn enough to require replacement are the rods making up some of the pinions. You may not want to go into such fine detail, but if you must, it's nice to know that brads of the right length will serve very well as replacements. They may be soft soldered in place after assembly.

Difficulty with the strike mechanism can most often be traced to the wire levers being out of shape. Study the action carefully, and do not bend any wires until you are quite sure what the effect on the strike will be.

When you've cleaned up as many parts as you can, reassemble them as shown by your placement markings. Oil the bearings, the pallet faces, and the crutch loop as described before. If the clock is spring-



Oiling the escapement bearing. A needle stuck in an eraser is used to apply the oil. Make sure that it's genuine clock oil—not light machine oil—and put it on in tiny droplets.

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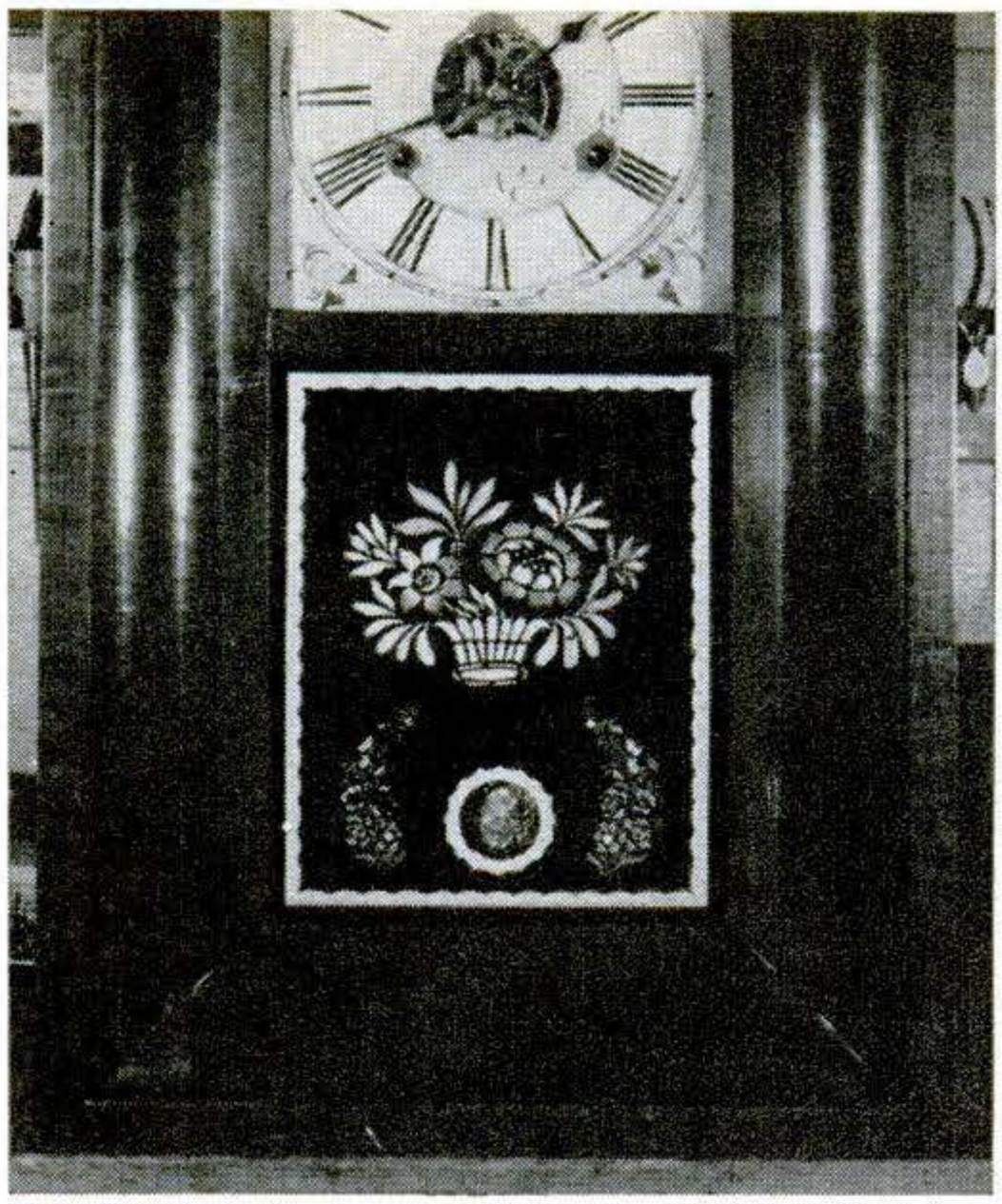
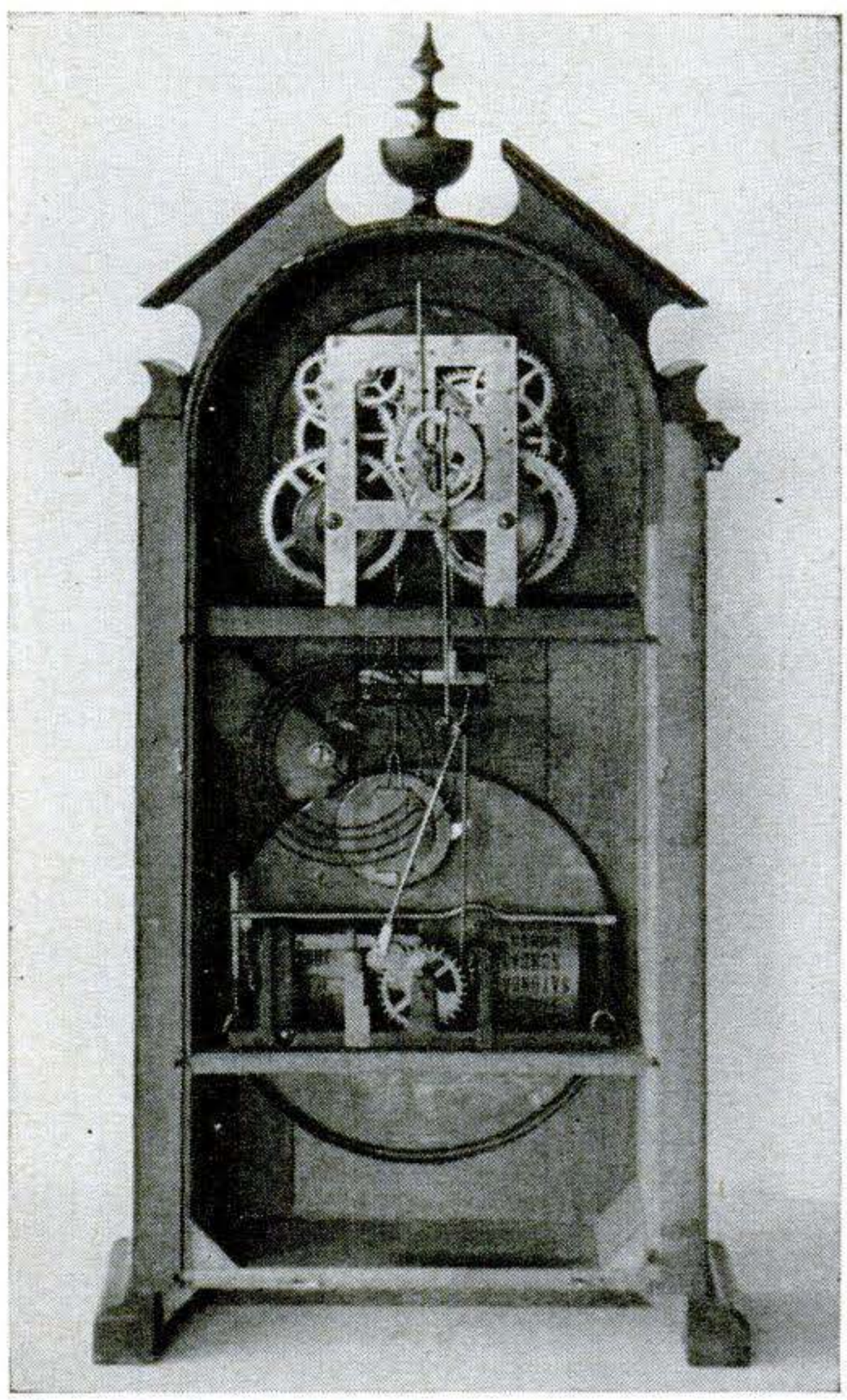


Hand decoration replaces an original painting that was beyond saving. The window allows the movement of the pendulum to be seen.



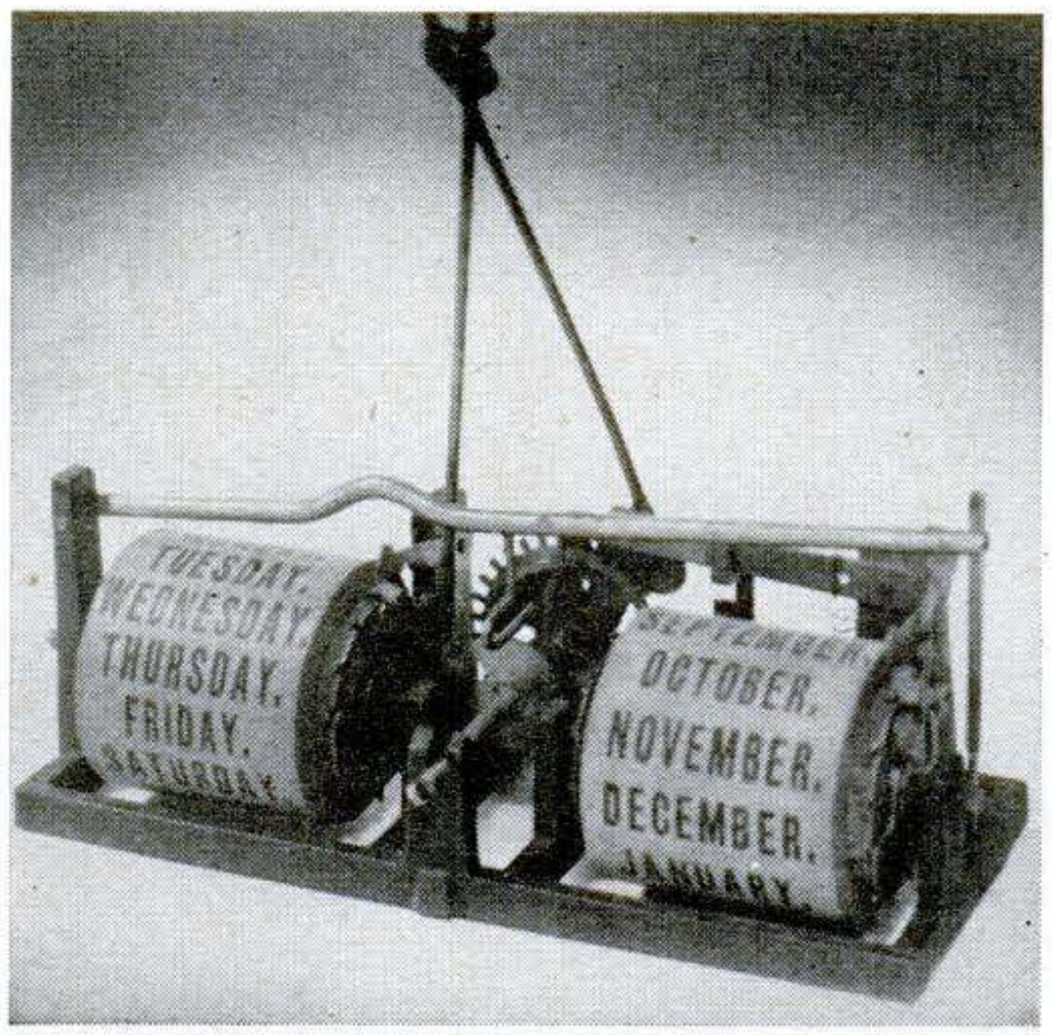
This 1865 calendar clock (seen in front view on p. 212) has a timekeeping mechanism similar to the one above but also records dates.

driven, mount it temporarily so it can run while the case is being refinished.

The easiest way to remove the old finish is with commercial varnish remover. Before applying it, mask the painting and clock paper. Veneer for patching can be obtained from most cabinet shops, as can scraps of walnut or mahogany. After completing all repairs, sand the case with fine 00 paper. Stain and thin shellac make a serviceable finish and may be better than a natural finish if you've had to do any patching on the veneer.

As a final touch you can turn your attention again to the painting on the door glass. If you have managed to preserve most of it with the shellac binder, simply fill in whatever blank or damaged spots that may have been left. Use thinned oil colors mixed with a little varnish. Blend and test the colors carefully, making sure they match the original tints. Should the original be damaged beyond repair, scrape it off and replace it with a mirror, a colored print, or a painting of your own design.

Install the movement in the case and place it on a level spot. If the pendulum does not swing equally to each side, bend the crutch until it does. Move the pendulum from one release position of the escapement to the other; both angles should be the same. Test it also by listening. The "beat" is correct when the clock says *tick, tock* with equal spacing. Adjust the rate by raising the pendulum bob for faster time and lowering it for slower. END



Perpetual-calendar movement automatically resets itself for short and long months. Every four years it puts 29 days in February.

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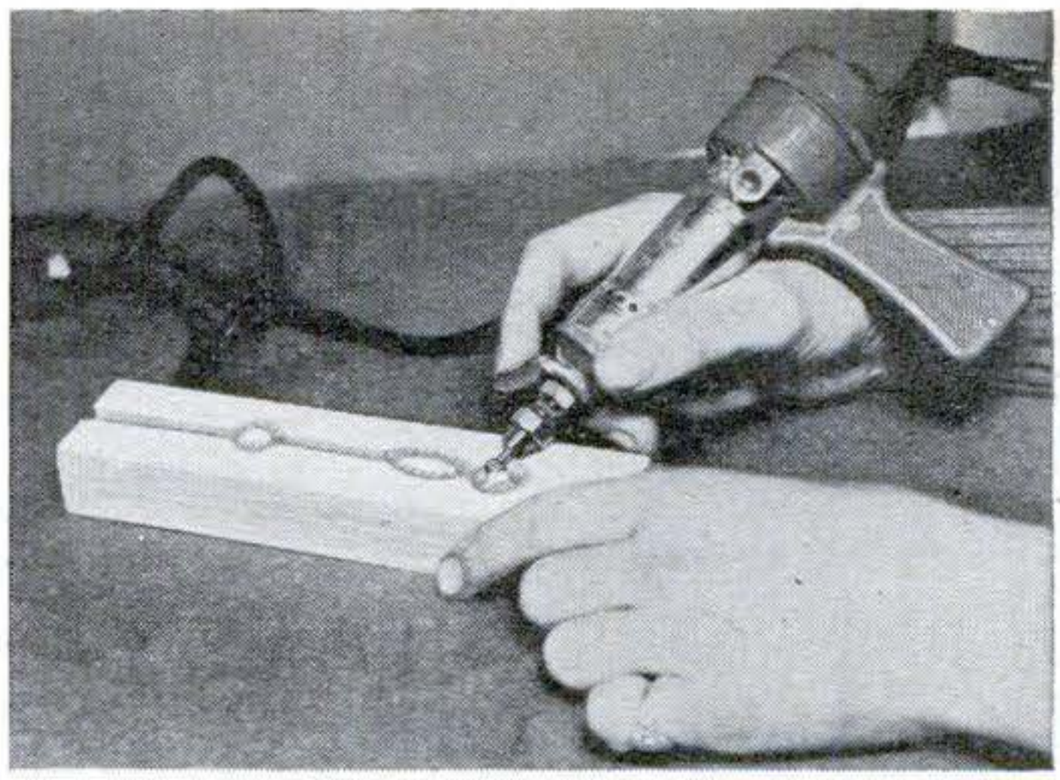
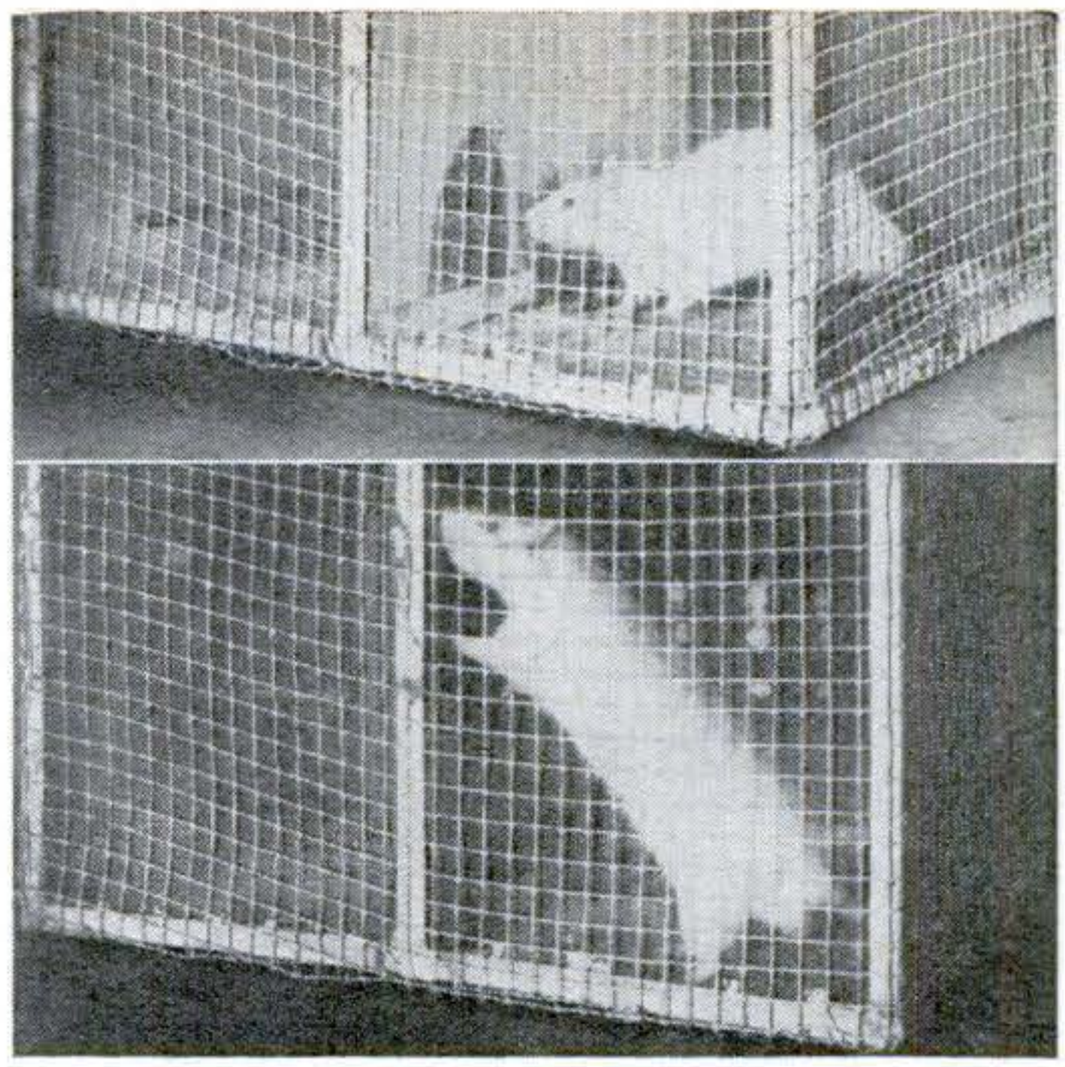


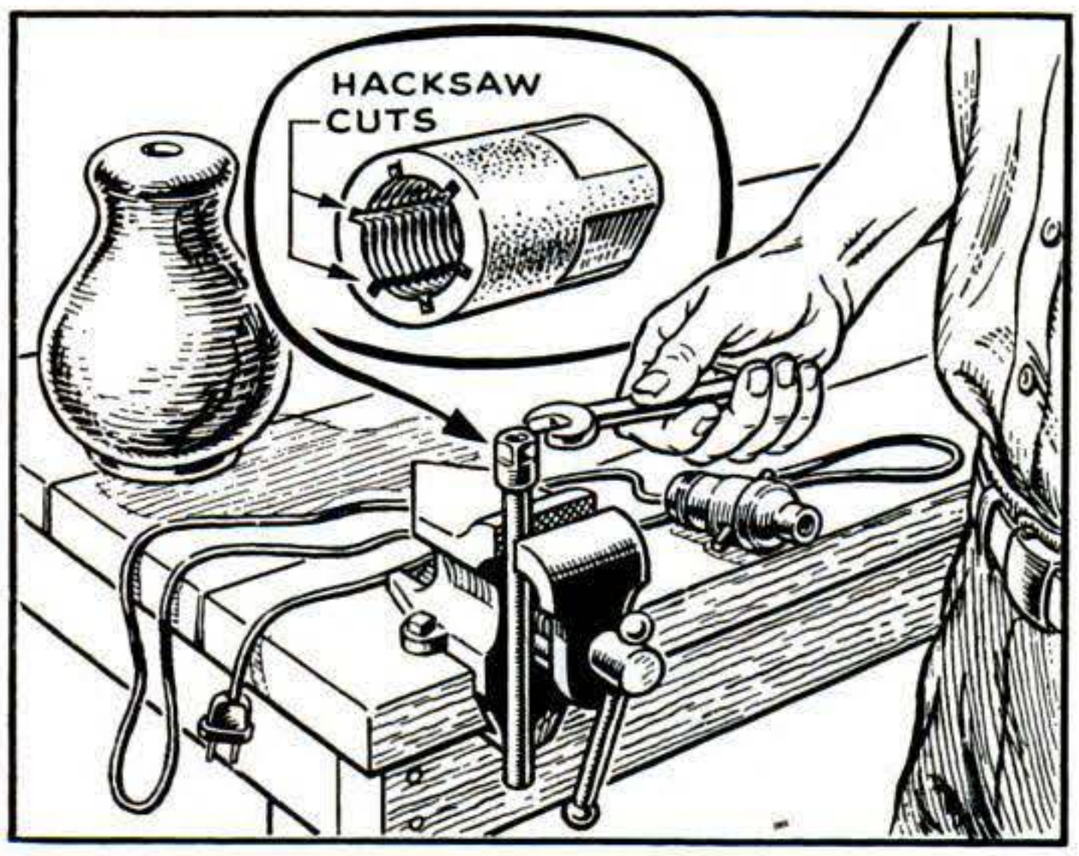
Making New Hands for Clock

MANY of the older wall clocks had lead hands. If these are lost or broken, you can cast a new set with a block of wood for a mold and solder for metal. First draw the outline of the hand on a pine block. Then with a ball-shaped burr in a hand grinder, rout out the wood about ⅛" deep inside the outline. Use an end cutter to level off the bottom of the outline. Now pour molten solder in the mold. When it's cool, use a rasp to dress down both the top of the block and the solder until the hand is 1/16" thick. Pry out the casting and finish with a small file. It then can be coated with a black enamel.—*R. F. Yates, Lockport, N. Y.*



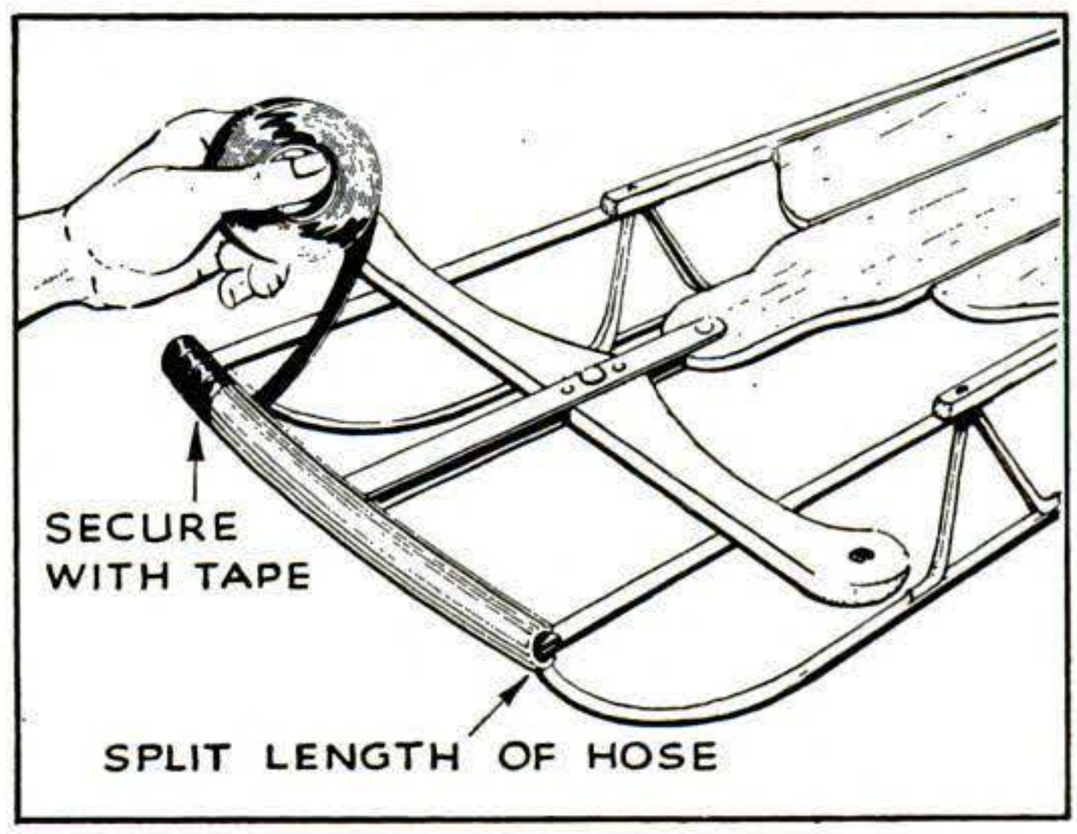
New Plywood Keeps Out Rats

DEVELOPED by the United States Plywood Corp., a low-cost board called Protekwood(T) can be used to ratproof buildings and bins containing grain. In tests comparing boxes made of Protekwood and ordinary wooden boxes, rats gnawed their way through the wood but were repelled by the composition board. It is made of a hardwood veneer with impregnated fiber faces. It is non-poisonous and does not affect food or animals.



Pipe Coupling Acts as Pipe Die

A PIPE coupling, grooved as shown in the drawing, makes a substitute die that will cut threads on bronze, brass, or copper tubing. I used a midget hacksaw to cut the six grooves inside the coupling, and then ground one end of the outside square so I could turn it with a wrench. You'll find this kink handy when making up homemade lamps or electrifying vases or bottles for lamps.—*A. K. Lord, Westminster, B. C.*



Garden Hose Covers Sled Front

THE sharp metal bar on the front of small sleds often causes bumps and bruises to youngsters. A protective covering, made of a piece of discarded garden hose, will form a cushion over the bar. Cut the hose to length and slit it. Then trim it with a sharp knife until it fits the bar snugly. Friction tape wound tightly around the hose and the bar will hold the bumper in place.—*R. M. Woodbury, Haverhill, Mass.*

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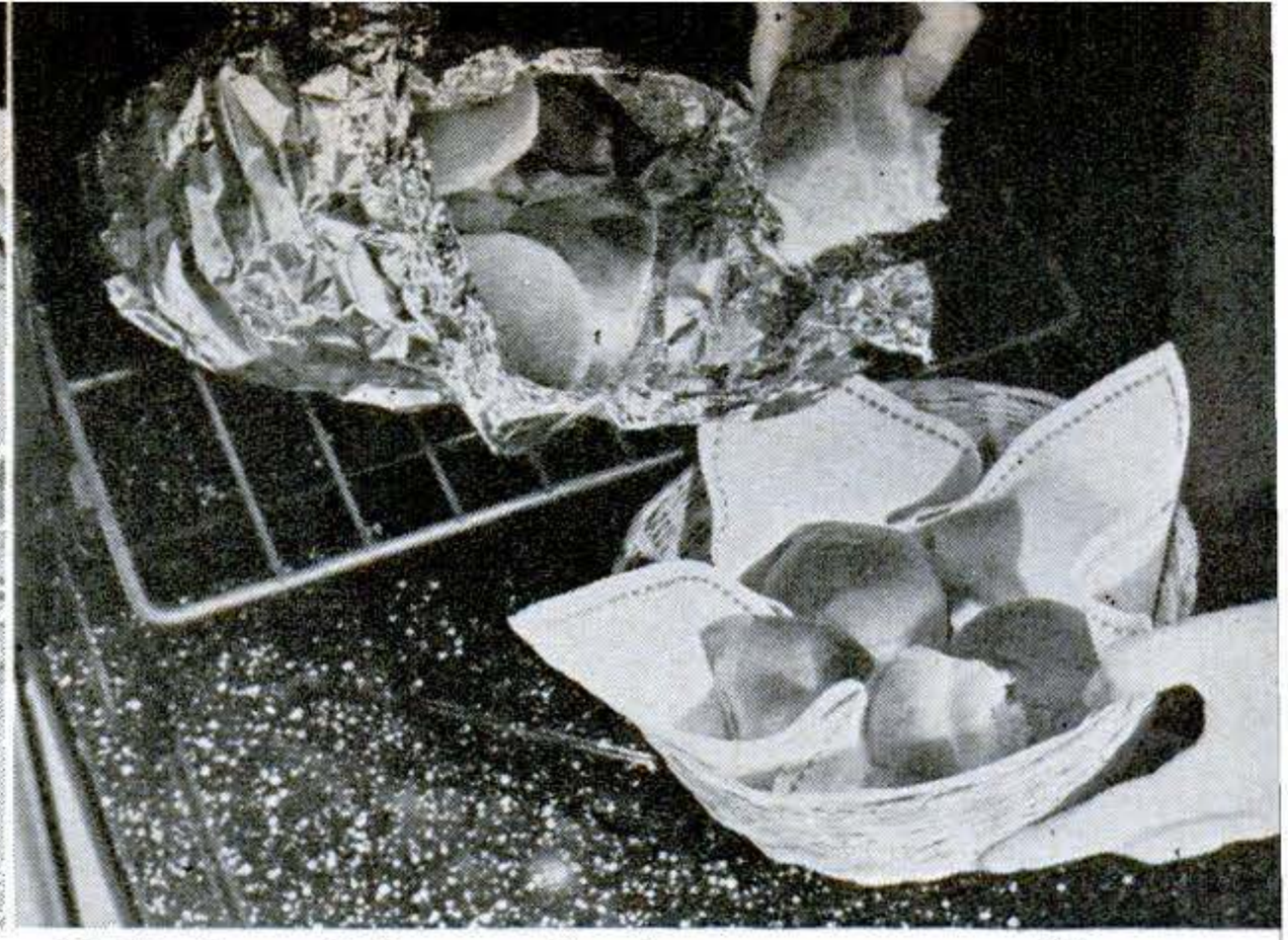
For picnics or for lunches at school or work, if the foods are wrapped in foil, you can even take along a slice of your favorite juicy pie. The juice can't soak through the aluminum.



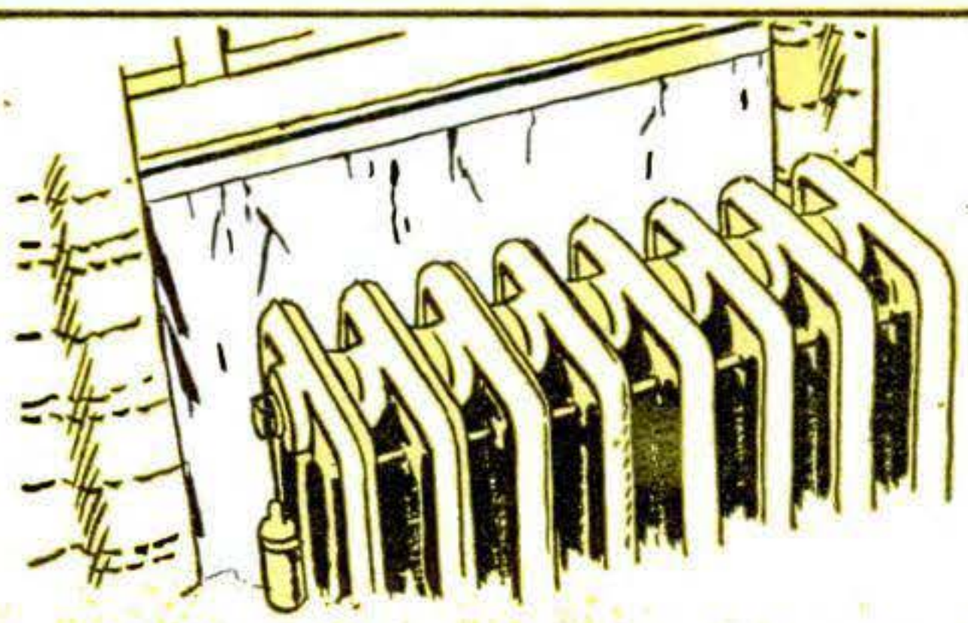
Rolls heated in an aluminum wrapper will not scorch if forgotten for a few extra minutes in the oven. If served in the wrapper, they'll retain their heat longer at the table.

Aluminum Foil Goes to

JACK-OF-ALL-TRADES—that's aluminum foil, the handy-man material you can put on the job in dozens of ways. Houseware stores sell it in rolls like wax paper. It comes in two sizes and two thicknesses. It is grease-proof, waterproof, and it will readily withstand freezer and oven temperatures. Pieces usually can be used several times before they are thrown out, and as a rule the foil doesn't have to be taped or tied for most uses. It is pliable, but stiff enough to retain the shape into which you fold it. Besides

With bags of foil, your wife can cook more than one vegetable in the same pot. Cut round pieces and fold up the sides.

At the beach next Summer you can wrap wet bathing suits in the foil. Then you'll have a dry bundle to carry home.



A large piece of foil tacked or glued behind a radiator will reflect heat out into the room. Use the heavy grade.

Fold salt and pepper in squares of foil to take along on picnics. When ready to use, prick the wrappers with a fork.

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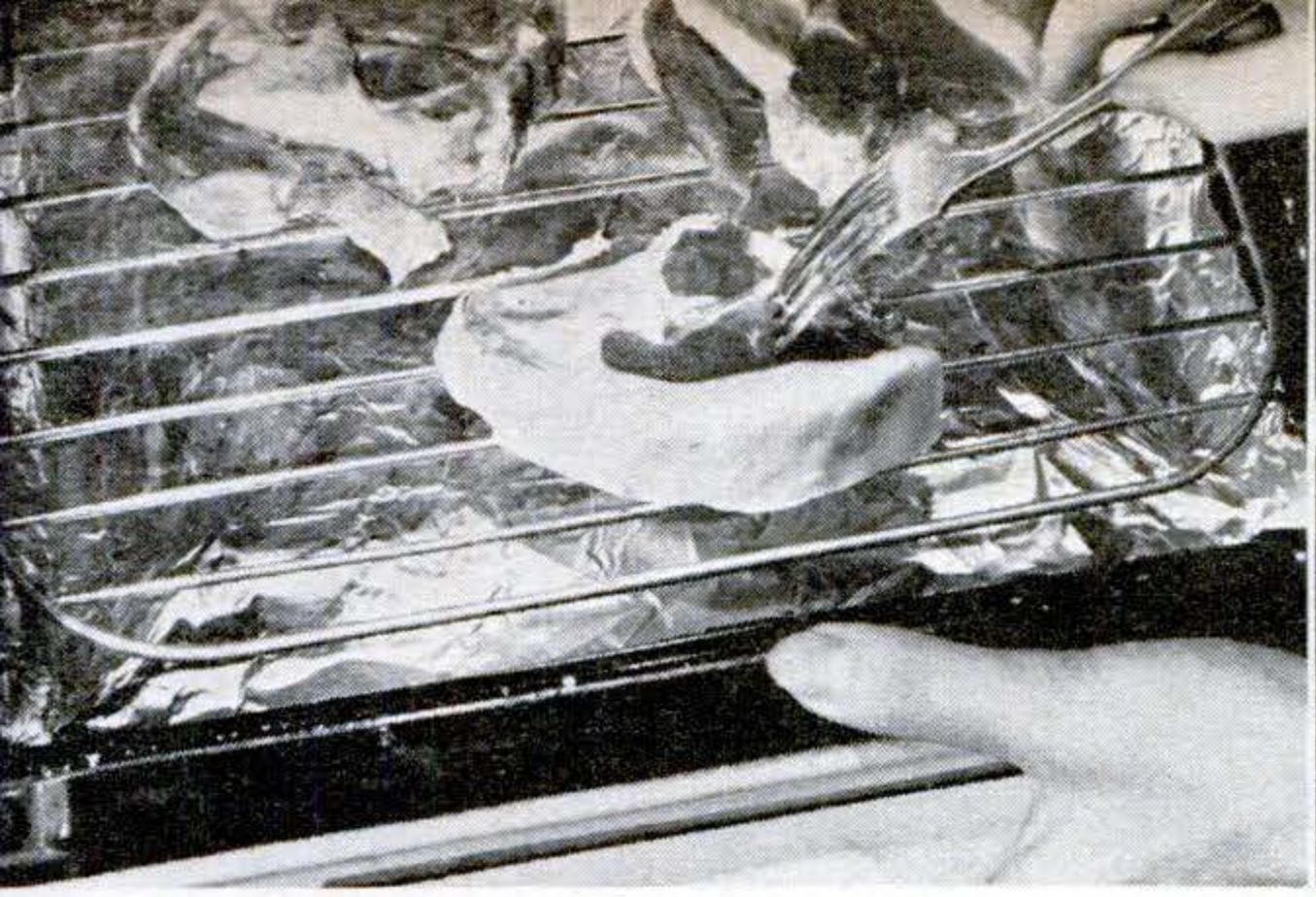
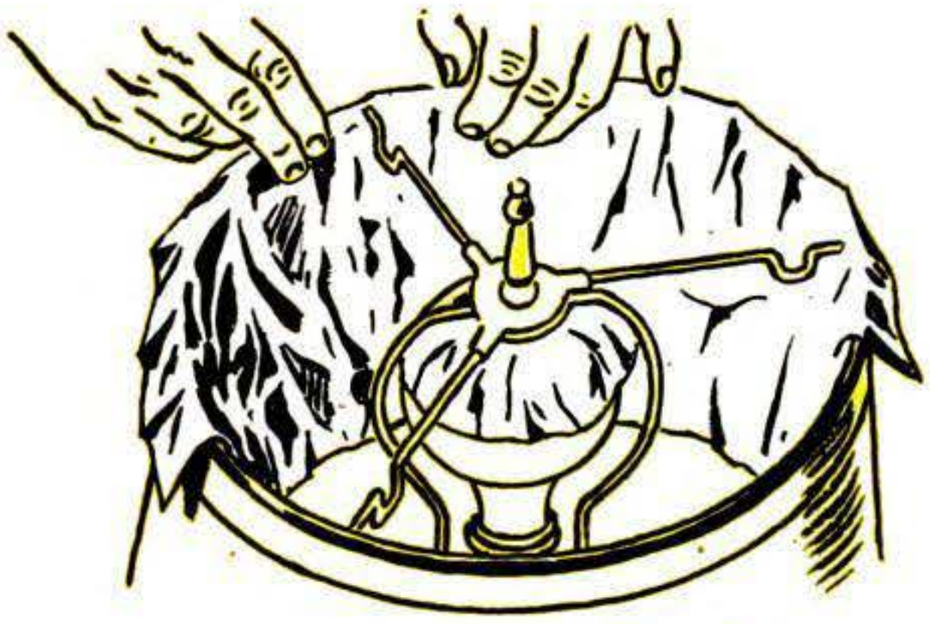


Here's a use your wife will like. It does away with the messy job of scouring the broiling pan. Line the pan with foil to catch drippings. Then throw away both foil and grease.

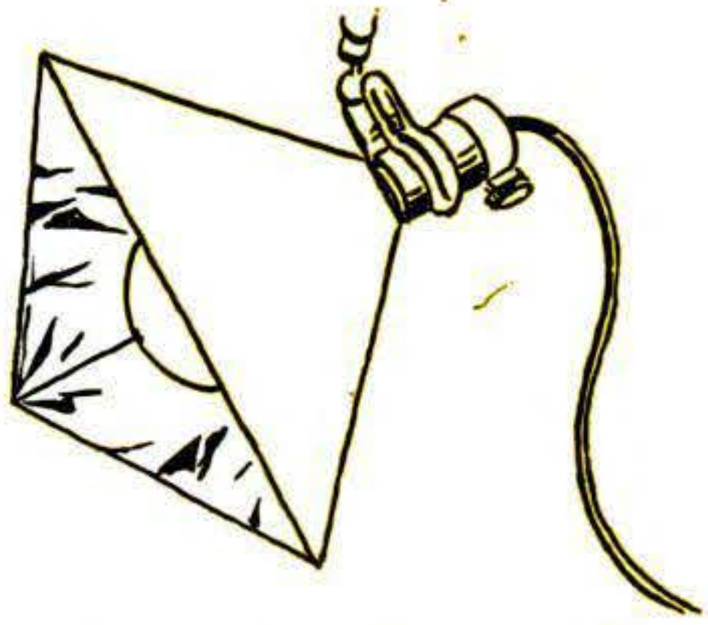
It's always best to clean a paint brush before putting it away, but if you suddenly have to interrupt a job, wrap the brush in foil. It keeps air out, paint in, and the brush soft.

Work in Home and Shop

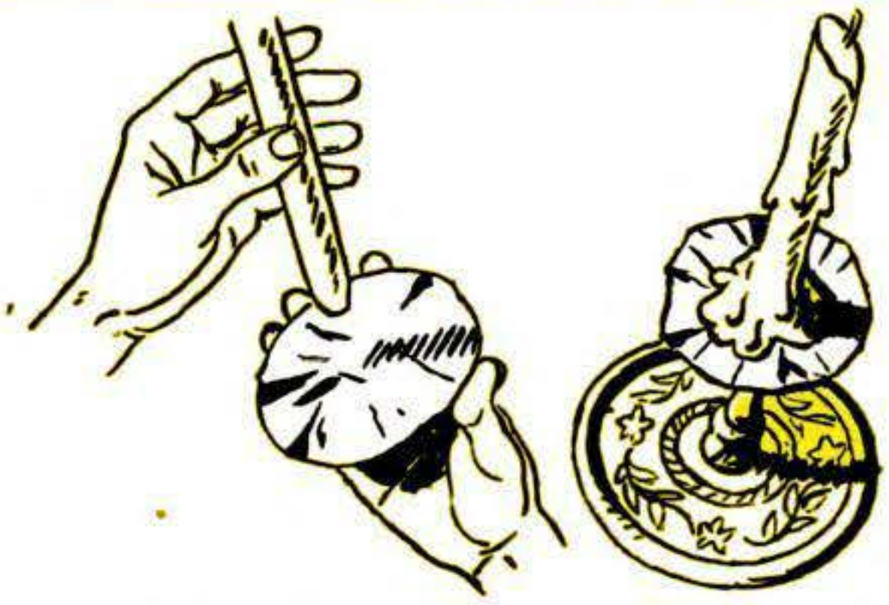
the even dozen uses illustrated on these pages, you'll find many others. For instance, if you need a spray on the shop or darkroom faucet, use the foil. Cut a piece about 3″ in diameter and fold it over the mouth of the faucet. Hold it in place with a hose clamp or wire. Then with a large needle or small punch, prick holes in it. Because it is grease-proof and waterproof, the foil is good for wrapping tools and machine parts for storage. Oil the parts and wrap them tightly and completely.—*Arthur Miller, Manhattan, N.Y.*



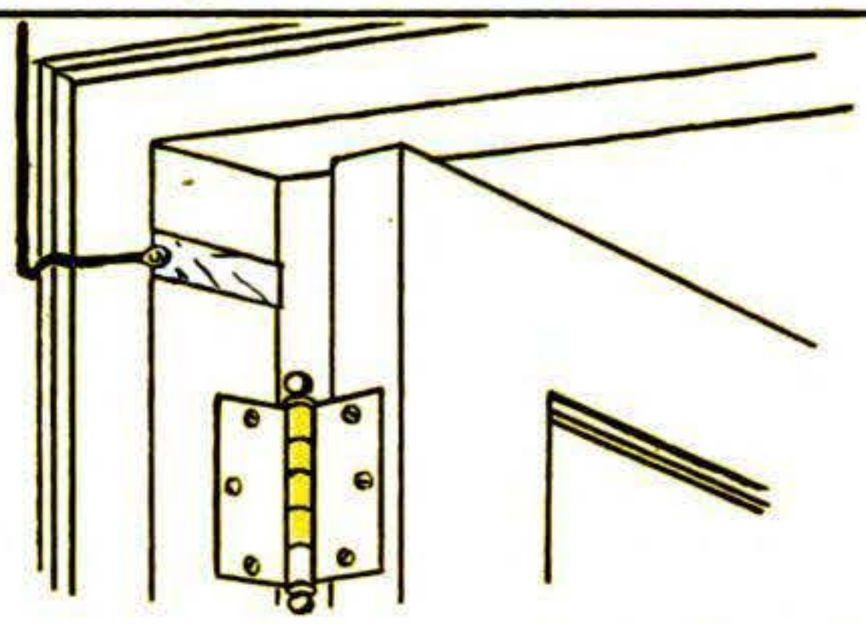
Lamps with dark shades will reflect more light if you line the shade with foil and press a circular piece over the bulb top.



With three pieces of cardboard and some foil, you can improvise a serviceable photo light. Tape the cardboard together.



Protect furniture from candle drippings by folding a 4″ diameter circle of foil around candle bottom. It'll catch and collect wax.



You can pass bell or aerial wire through a doorway without drilling a hole. Cement foil to jamb and attach wires with screws.

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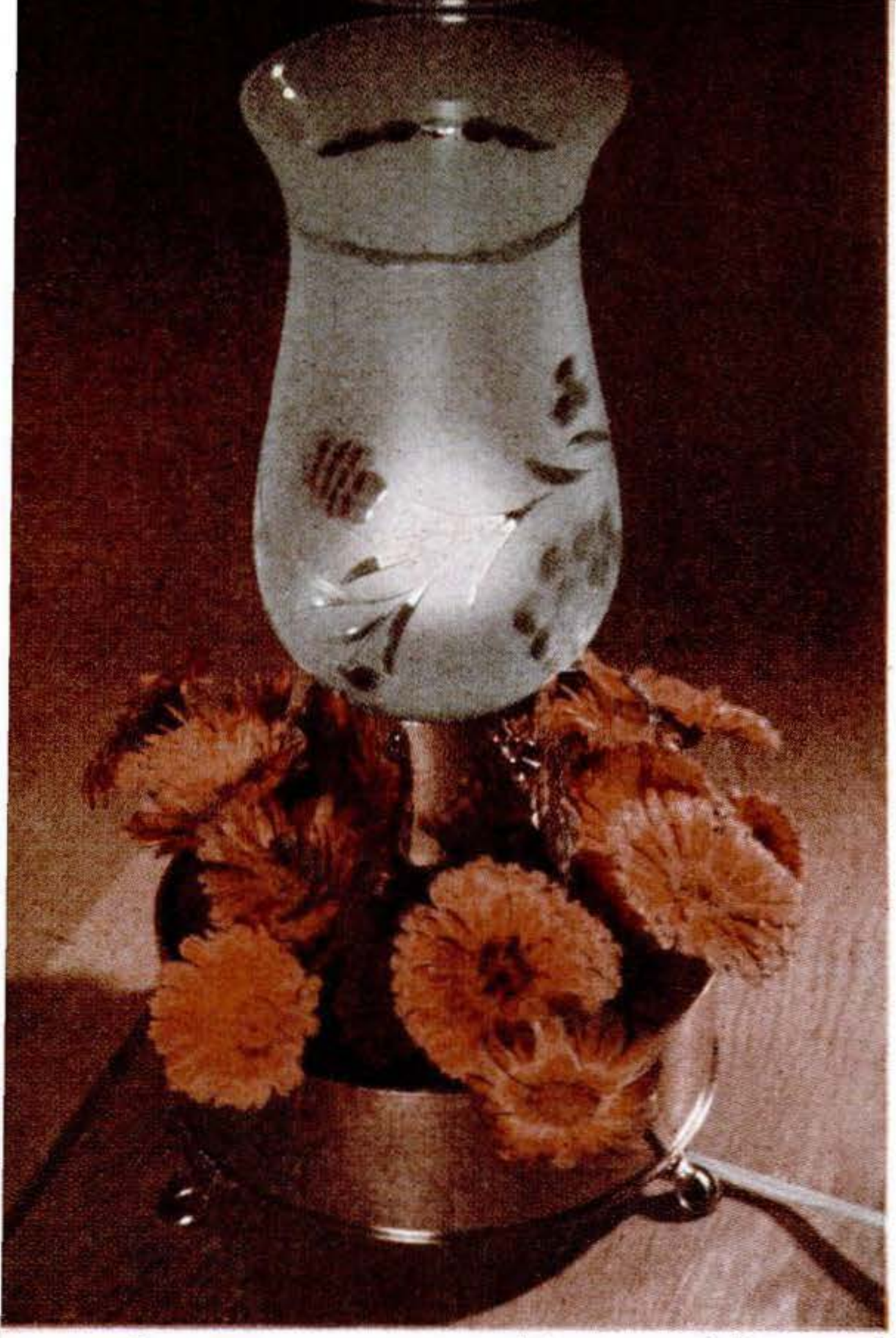


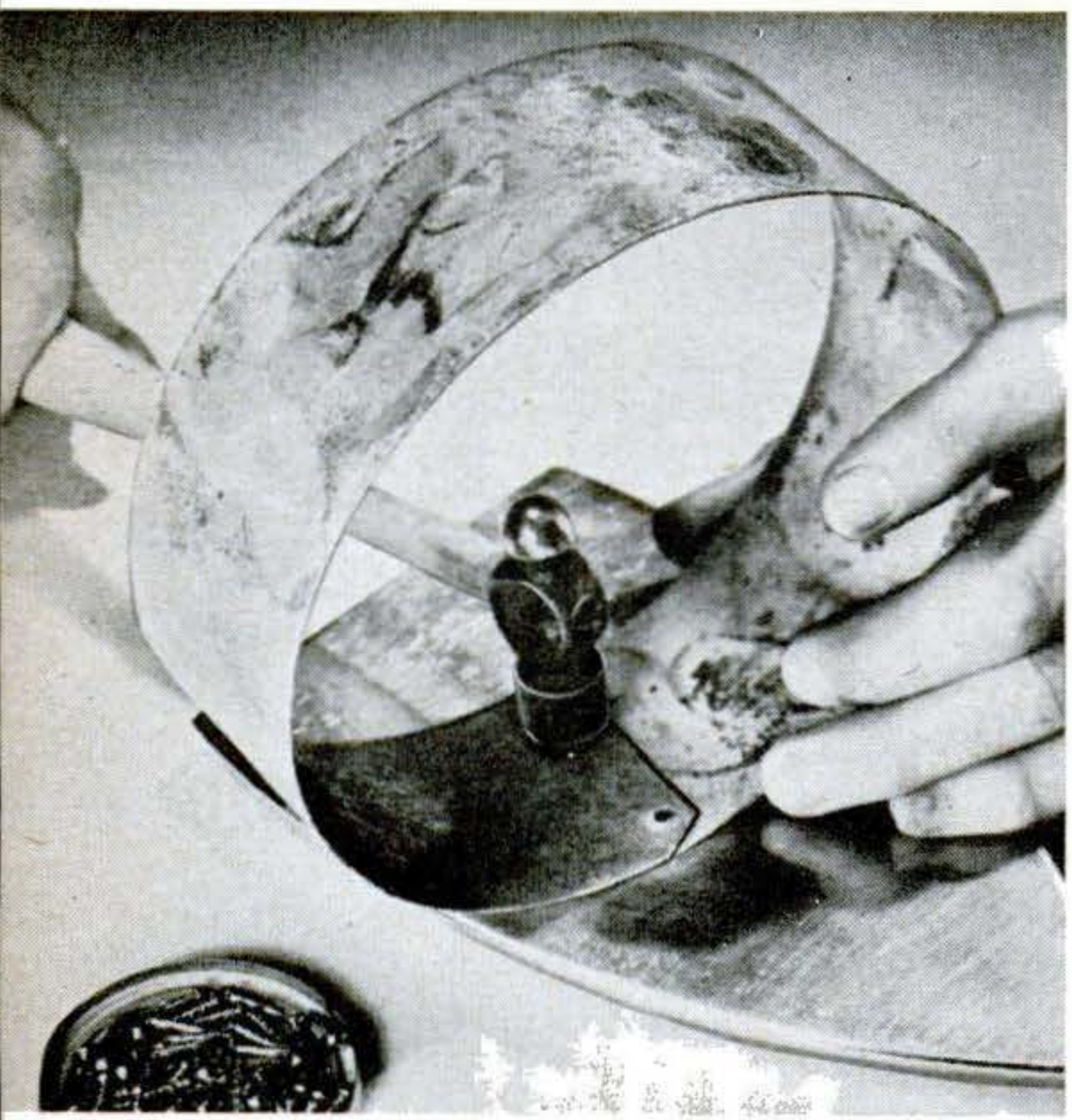
Lustrous copper, topped by a gracefully curved chimney, highlights your table arrangement. Top-lighted flowers are also at their best.

Table Centerpiece Illuminates Flowers

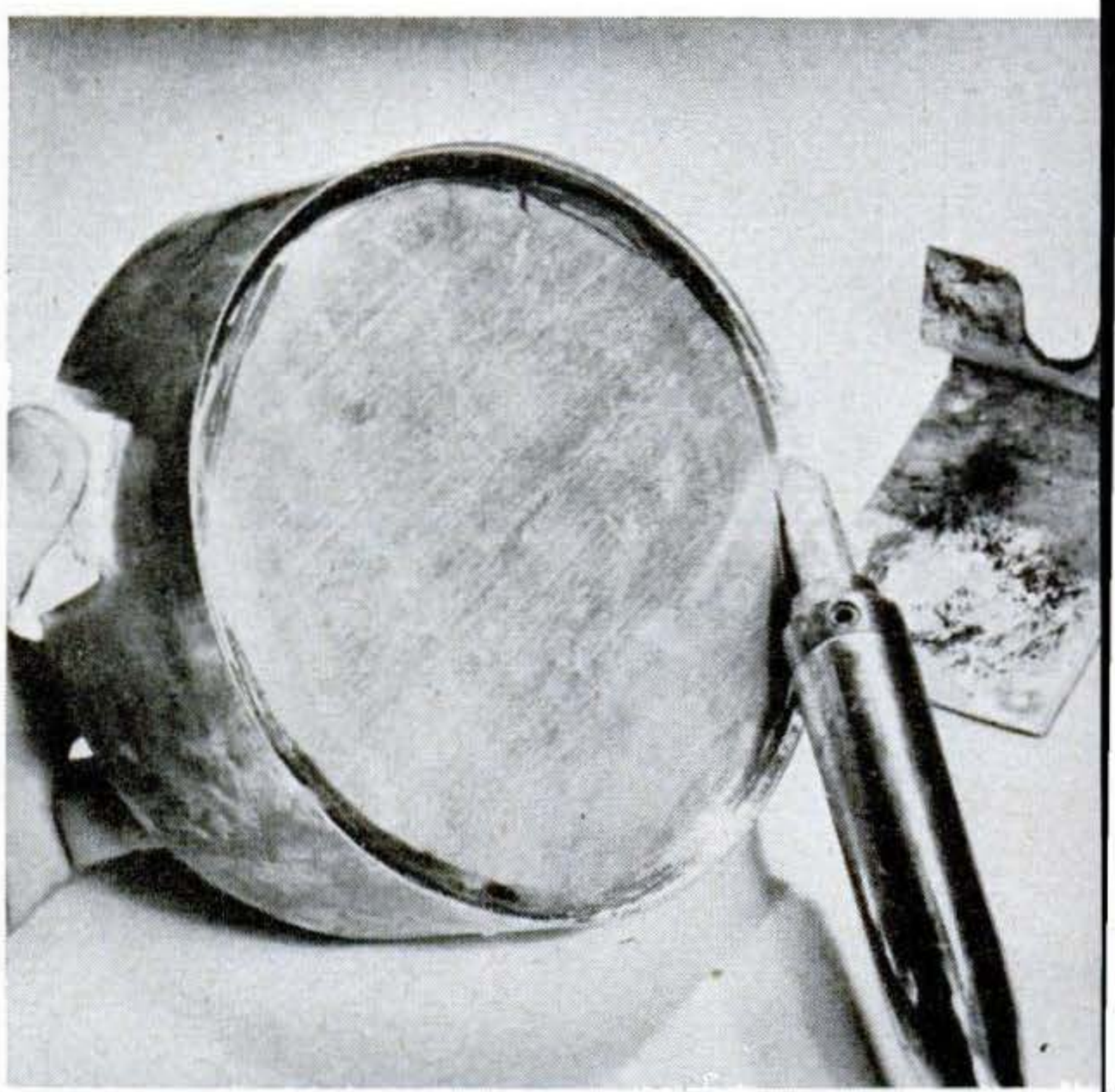
SOFT LIGHT and flowers are an unbeatable combination for dinner-table charm. In this centerpiece the light is diffused through a frosted-glass chimney, and the flowers may be either fresh-cut or planted.

The craftsman who wants to go all the way can make up the water tank and collar from copper as shown in the drawings and photos, but good results can be secured by cutting down two tin cans. A coffee can is suitable for the reservoir, and a smaller soup can will do for the collar, the scallops being omitted. The tin-can parts can be lacquered, enameled, or finished with copper bronzing powder.

First secure a suitable glass chimney, as the collar must be dimensioned to suit. The reservoir in the model shown was made from 16-gauge soft copper. A bead is formed around the top and bottom from 1/16"



Flatten the strip with a mallet, bend it into a 6" circle, and rivet the lap joint with brass escutcheon pins. Flow solder into the joint.



Place a 6" disk about ⅛" from the bottom and solder it carefully in place. A husky iron or torch is needed for a job of this size.

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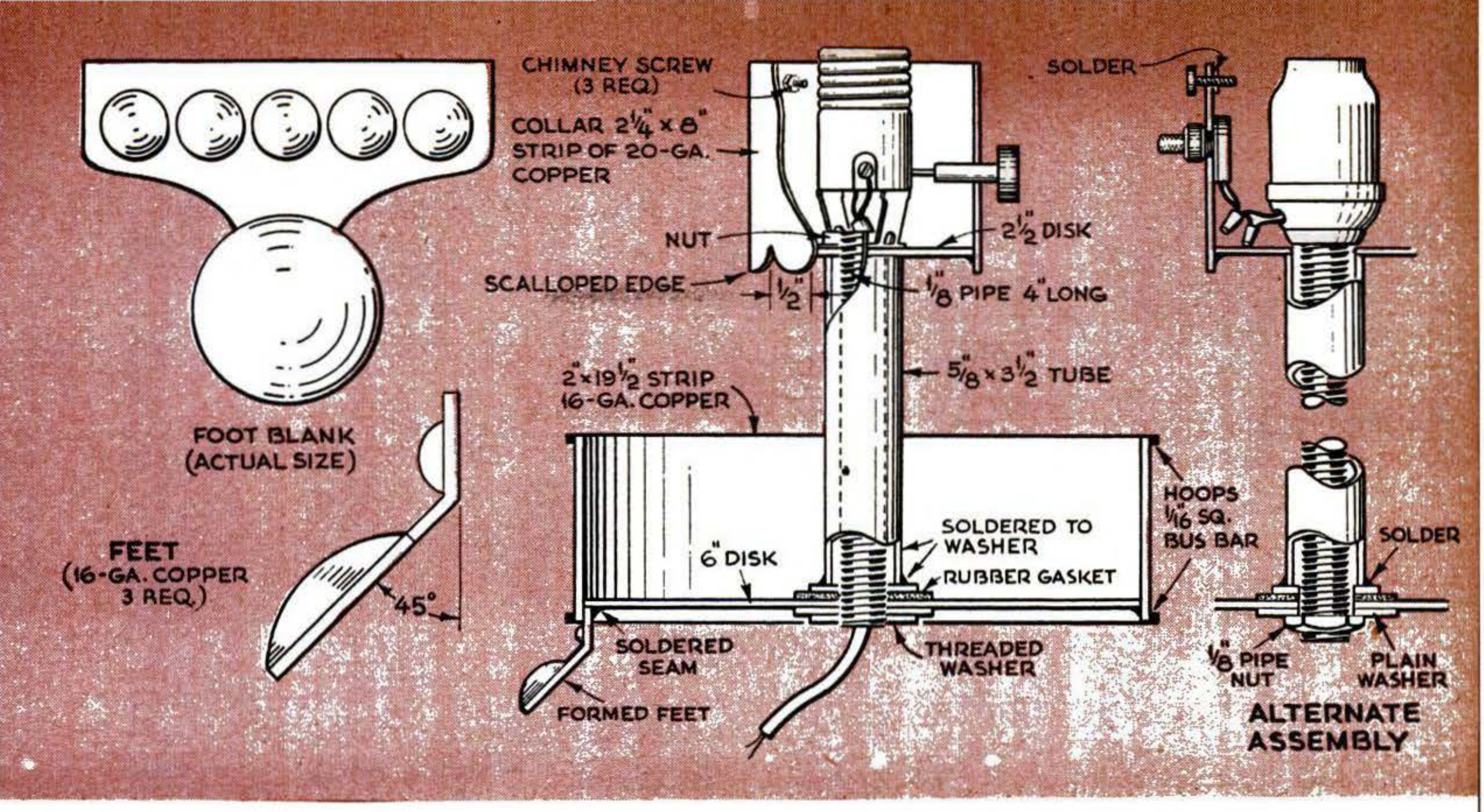
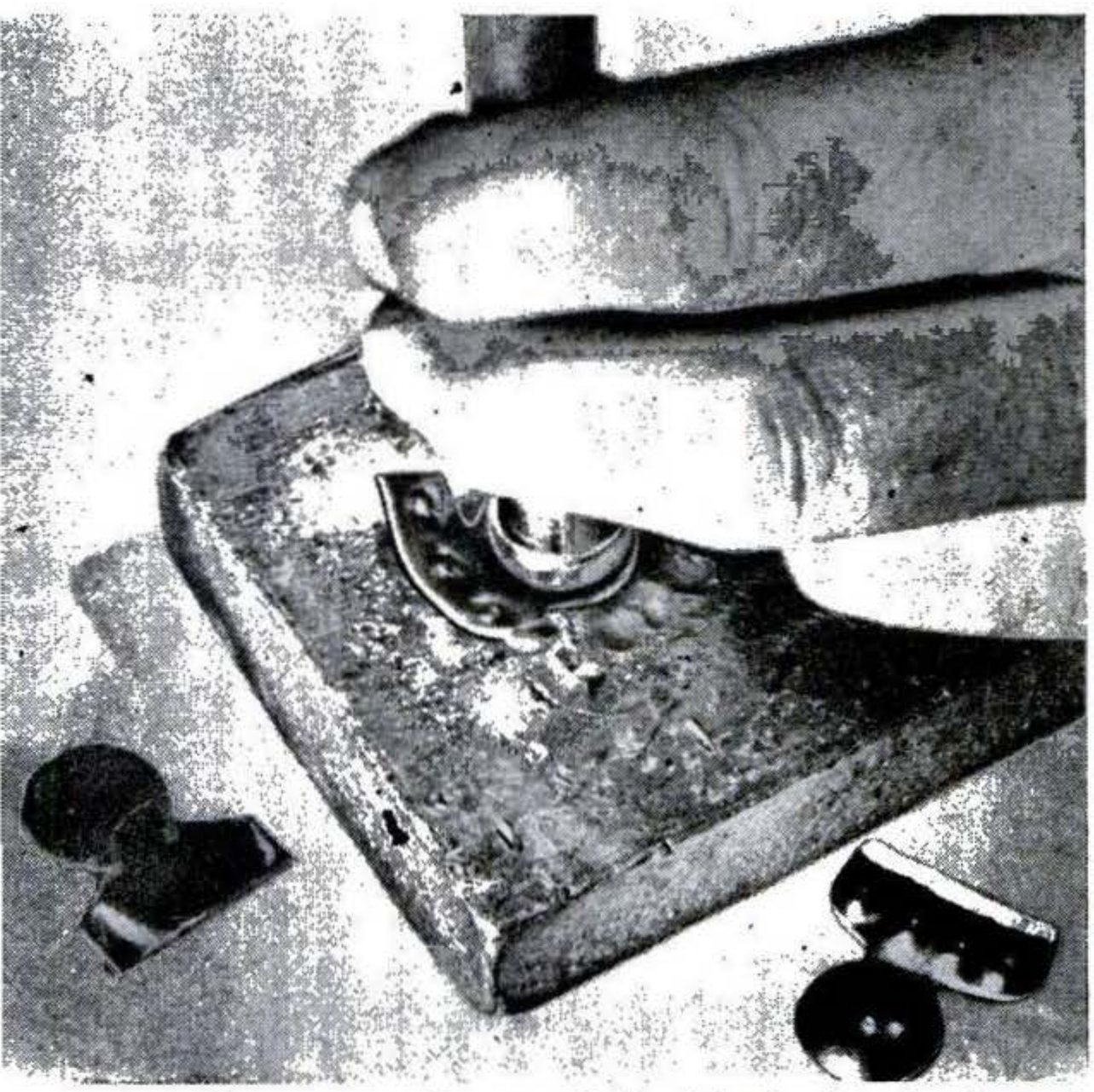


square radio bus-bar. Remove the tinning coat by heating the bus-bar red hot and plunging it into a dilute solution of sulphuric acid. Form the bar into snug-fitting rings and silver-solder the ends together. Tin the inner surface of each ring with soft solder and sweat it to the rim.

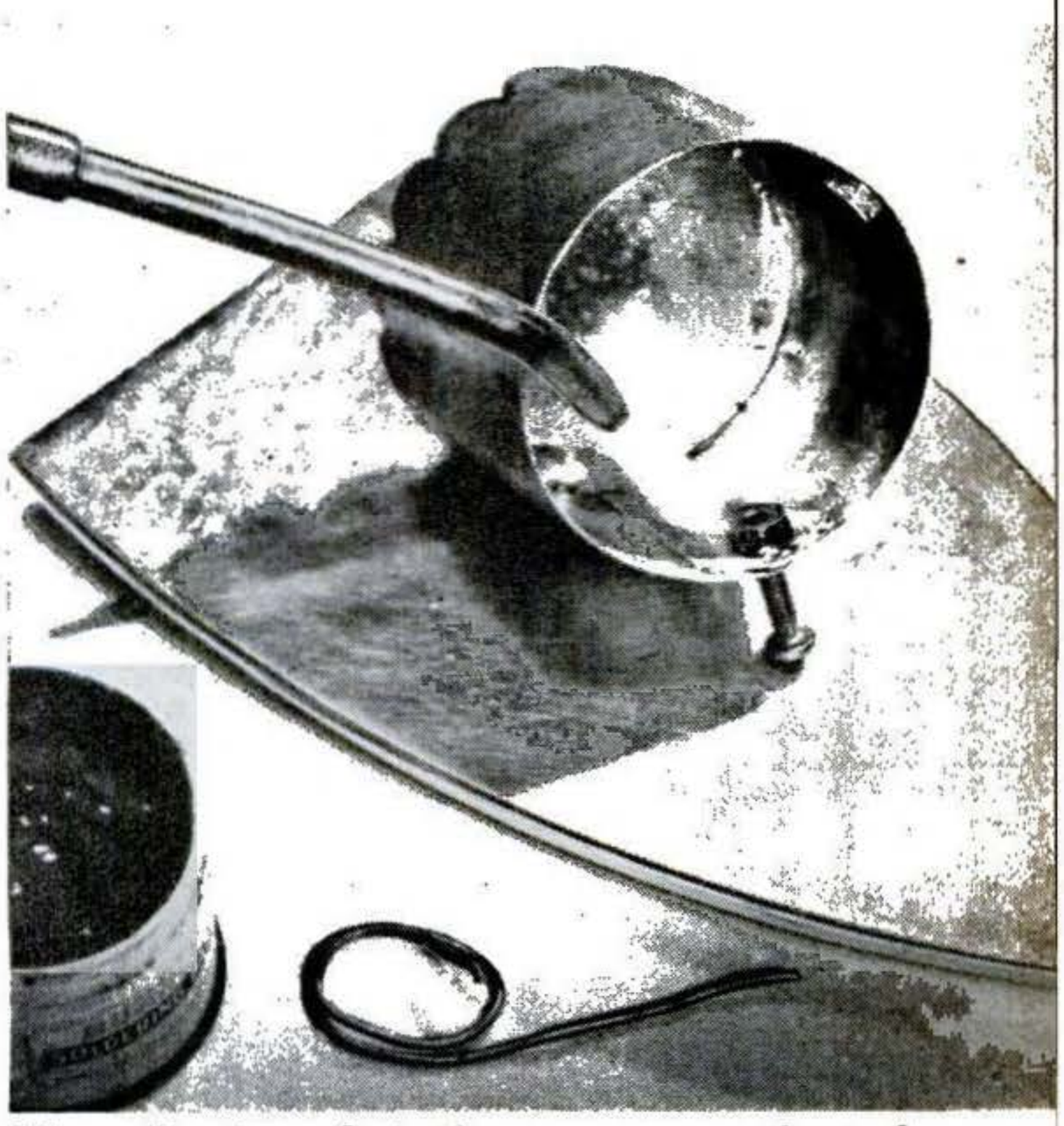
The collar assembly is fashioned from 20-gauge copper. Make sure that the three nuts for the chimney-fastening screws are soldered high enough for the bottom of the chimney to clear the switch.

A shaft or standard to support the collar is made of 3½" length of ⅝" O. D. copper tubing, and the sections are held together with a 4" piece of ⅛" running-thread pipe.

Test all parts with water to make sure there are no leaks. Wire the lamp and install a small bulb. Plant or bank with flowers of your choice.—*Bill Luther, Los Angeles.*



Cut out and anneal the blanks for the feet. A blunt nail is used to form the beading, and a ⅝" ball-tipped punch shapes the toe.



The collar is made in the same way as the tank but one edge is scalloped. Solder three nuts inside to hold the chimney-supporting screws.

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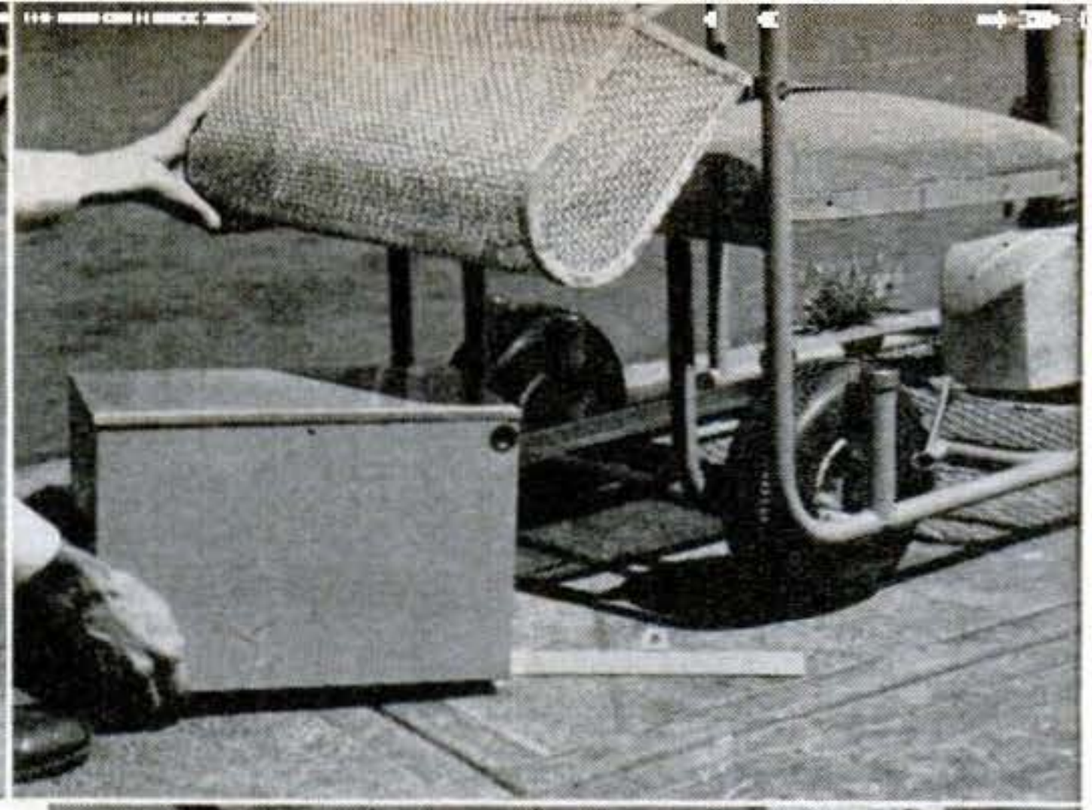
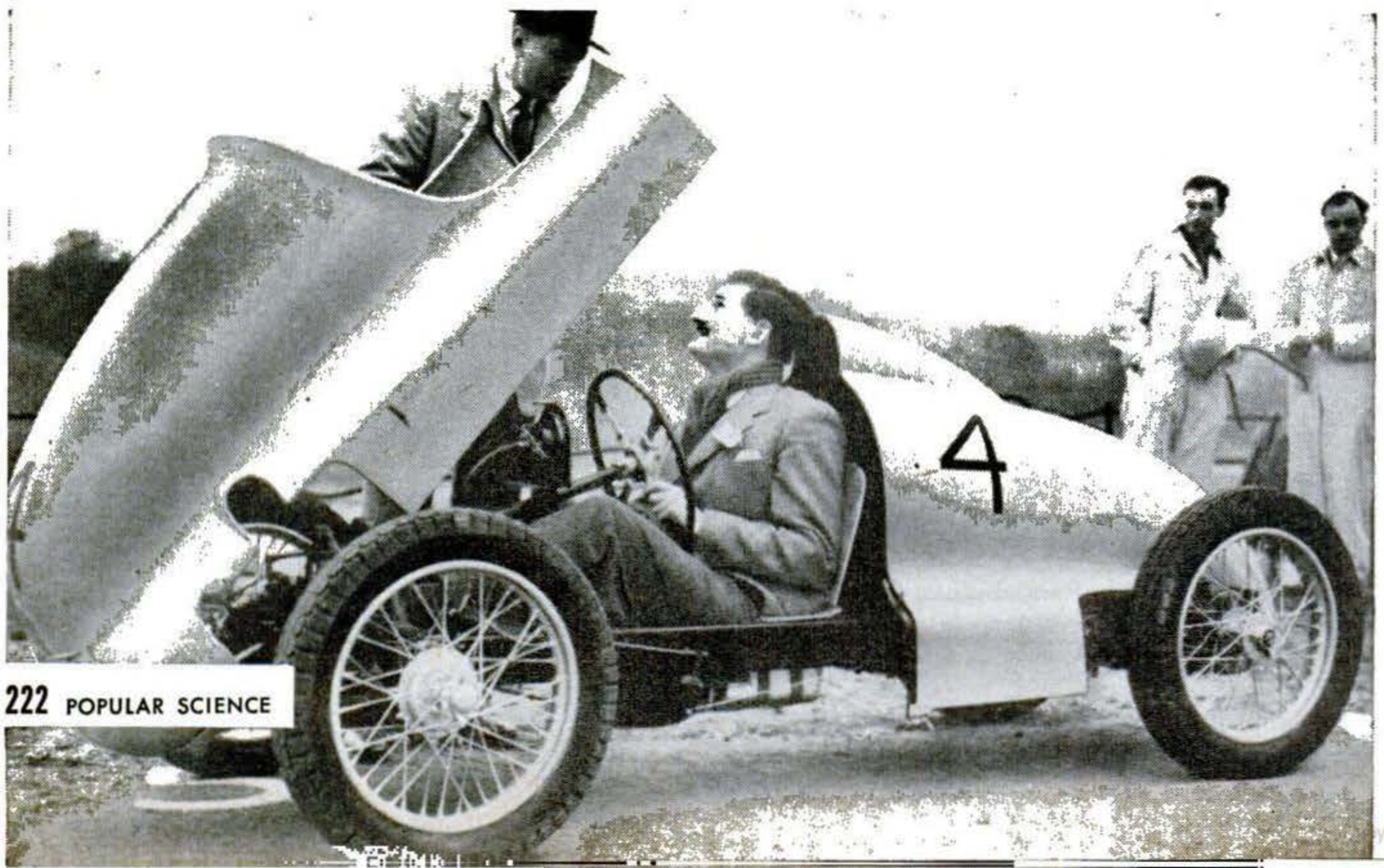


Batteries Power Light Scooter

DESIGNED for transportation within a plant, this 221-lb. scooter rolls on three wheels equipped with 10″ pneumatic tires. Two 6-volt auto storage batteries in series drive a 12-volt motor that is coupled by sprockets and a chain to the front wheel. The front wheel, motor and all, may be rotated through a full circle, current being fed to the motor by collector rings and brushes. To reverse the scooter, the driver swings the front wheel through a half circle. The control handle starts and stops the motor, selects any of three speeds, steers, and actuates a hydraulic brake. Top speed is 12 m.p.h. The batteries are in a steel case (upper right photo) that can be exchanged for a similar unit in 30 seconds. Beall Mfg. Co., Cleveland, Ohio, is the maker.

British Midget Racing Car Sold in Kit Form

PRODUCED by the Marwyn Car Construction Co., Wareham, Dorset, England, this 500-lb. midget racer may be bought as a kit of parts and assembled at home, if you're an expert mechanic. About 20 cars a month are turned out by the company, which also sells completely assembled models. The chassis comes with mounts drilled for a 4-hp., one-cylinder engine, but undrilled mounting plates also are available to suit other motors. Said to develop over 100 m.p.h., the engine burns wood alcohol.



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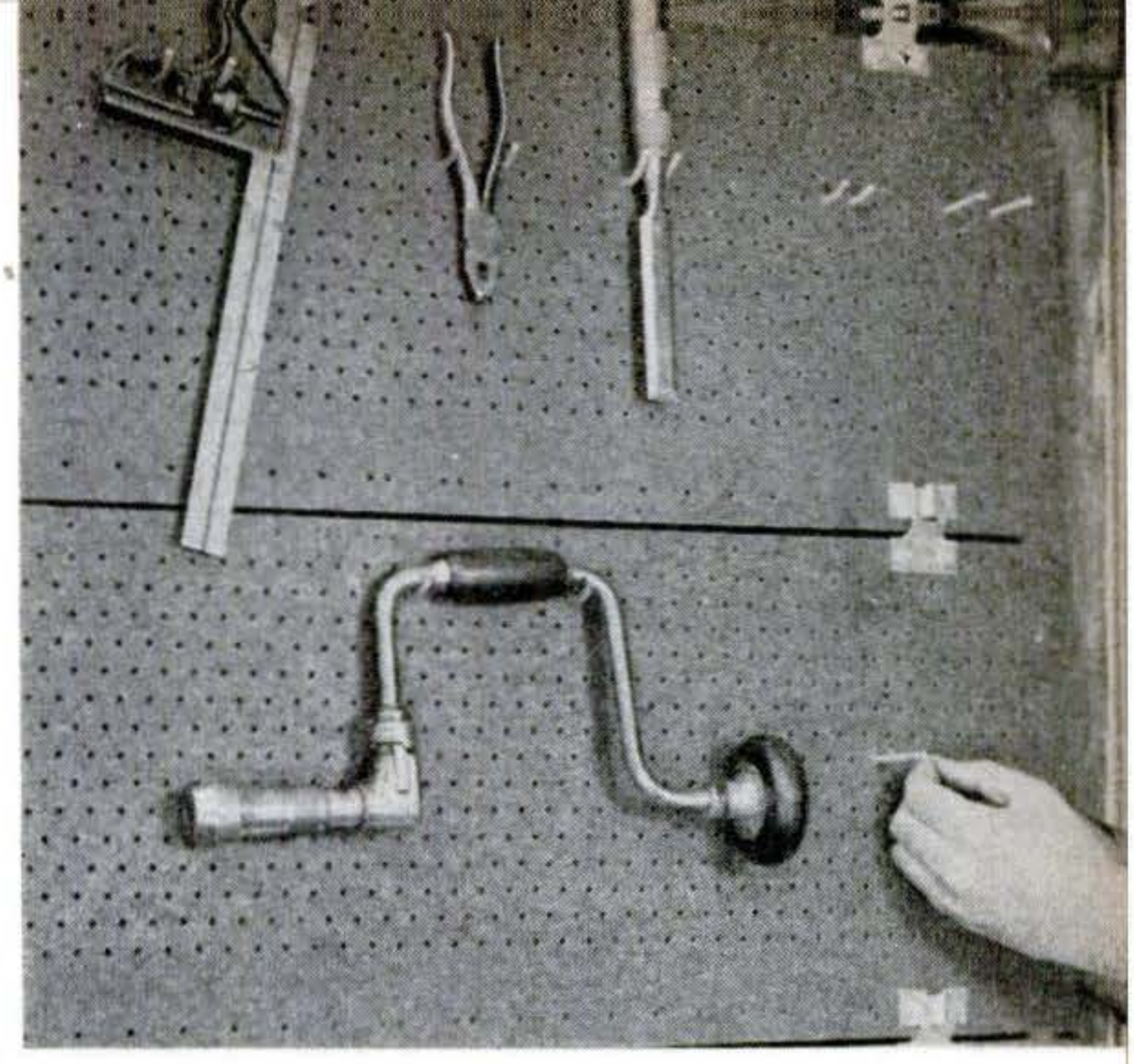
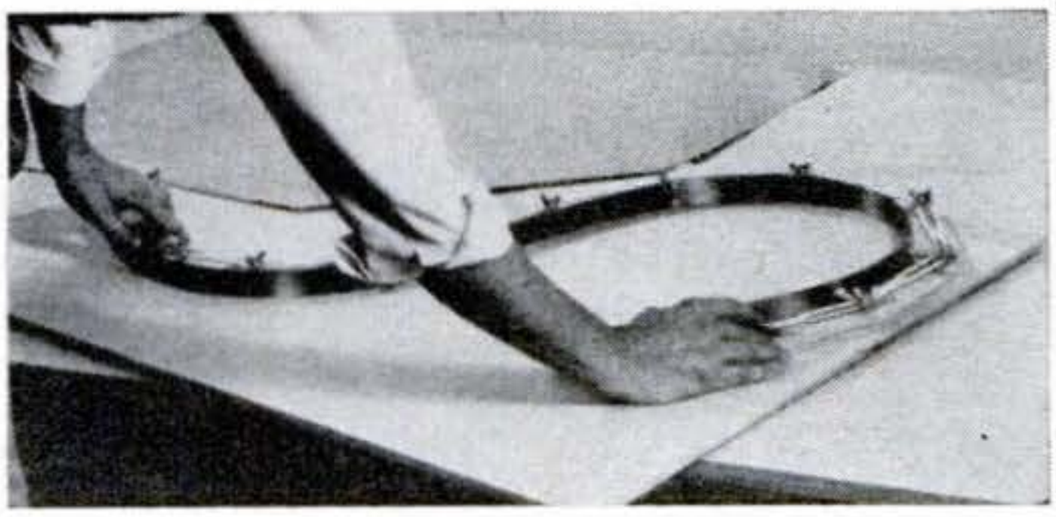
NEW TOOLS

Drum Conforms to Surface. The Nu-matic® grinder wheel, above, adjusts itself to curved, irregular, or flat surfaces. The trick is in a pneumatic rubber tube inflated at 3 to 10 lb., located between an aluminum core and a standard abrasive band. Made by Nu-Matic Grinders, Inc., of Detroit, it retails for $17.50.

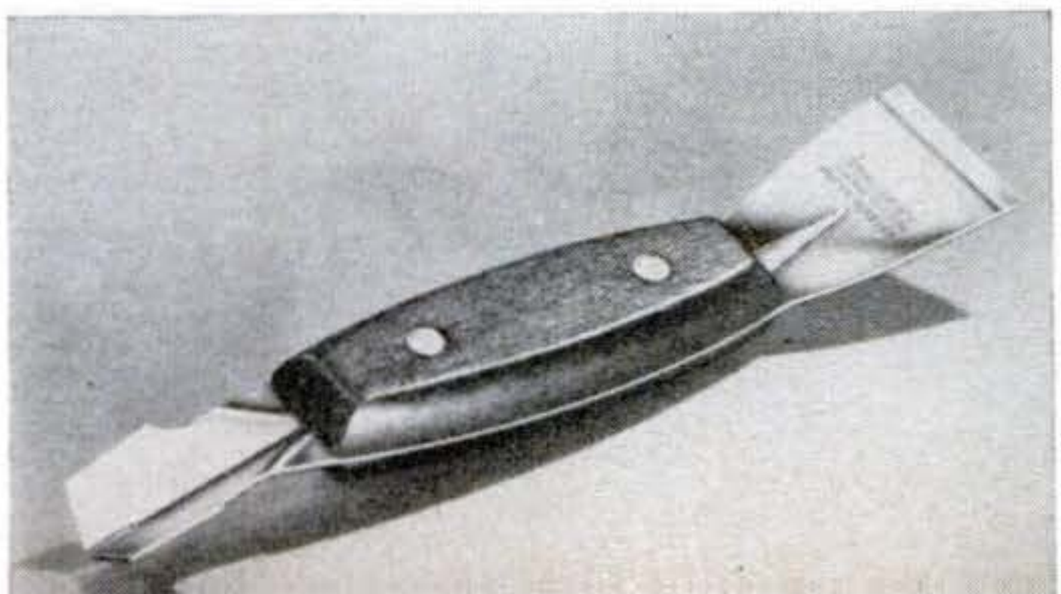


Panels Hold Tools. These adjustable tool racks, made by the Neetool Co., of Wichita, save driving nails into the wall. Punched in each 12″ by 36″ panel of ⅛″ hard composition board are 822 holes. Straight and curved steel pegs to fit these come in 1″, 1¼″, 1½″, and 2″ lengths. When stuck in, they're held by push-on clips.

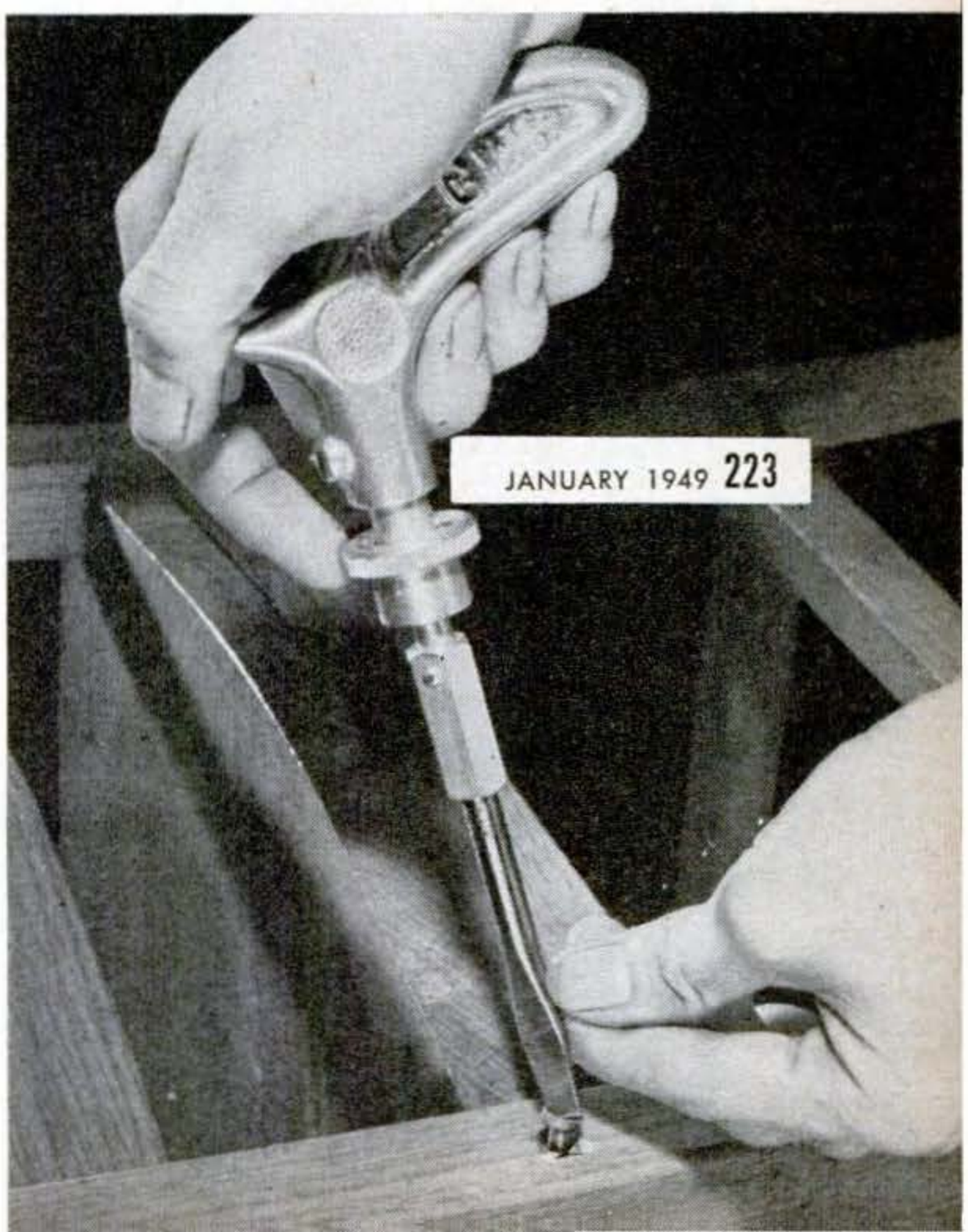
Template Is Flexible. The layout tool below speeds the duplicating of blueprint curves in wood, sheet metal, pipe, glass, plastics, and paperboard. A spring-steel tape with a screw-locking backbone, the Flexible Template® can be bent and set to any contour. It's then a portable pattern for layout or checking.

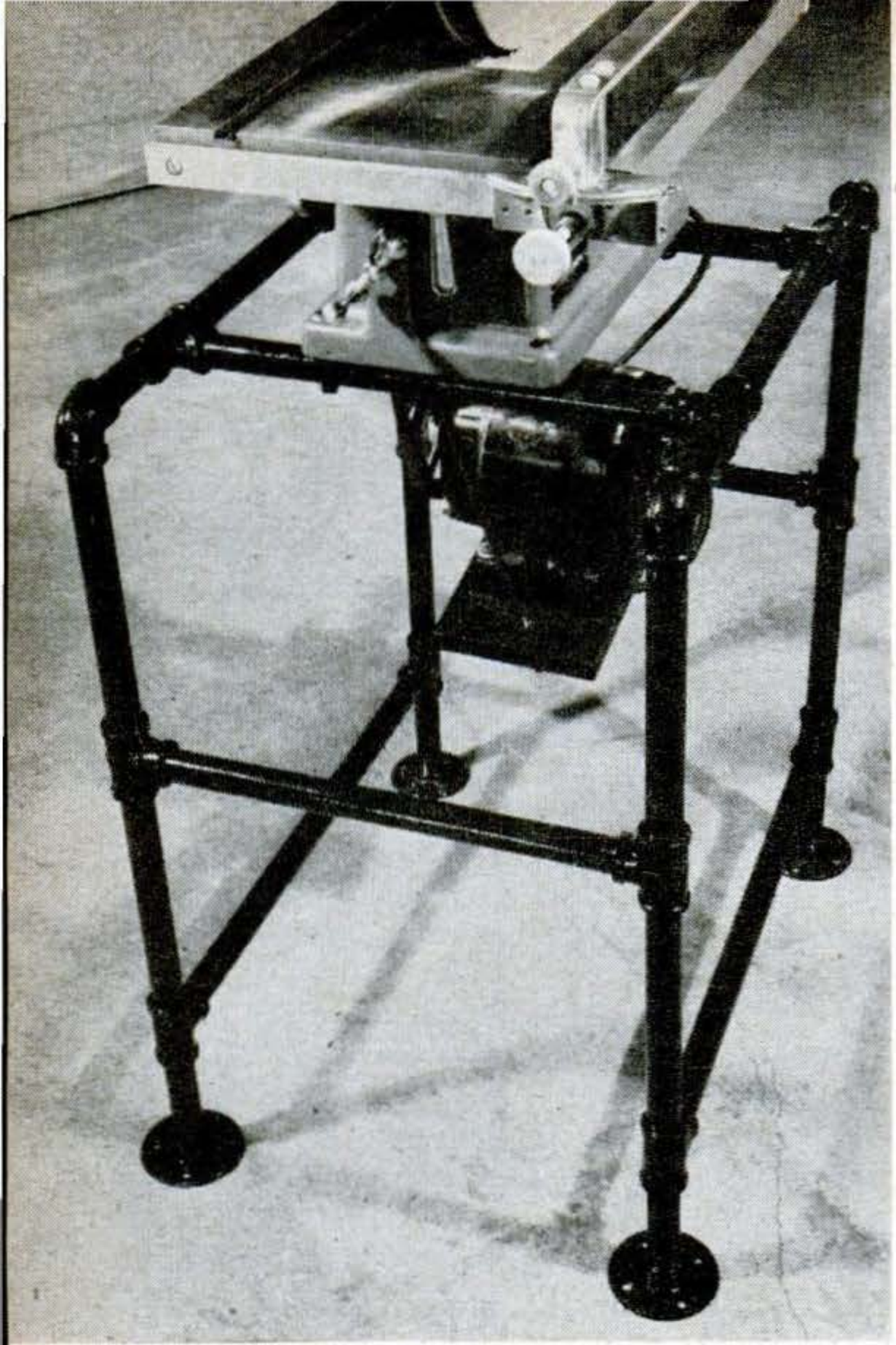


Blade Shapes Putty. Besides the usual flat spreader and scraper blade, the knife below has an angled blade that packs and shapes putty in a window sash. Selling for $1, it's made by the Fastener Corporation, of Chicago.



Screwdriver Has Pistol Grip. The handhold on this screwdriver (below) increases twisting leverage. Made by Big Four Industries, of Cincinnati, it has a mechanism that engages for driving (or unscrewing) with forward pressure. Partial release of pressure permits ratchet movement in either direction. It takes any standard bit.





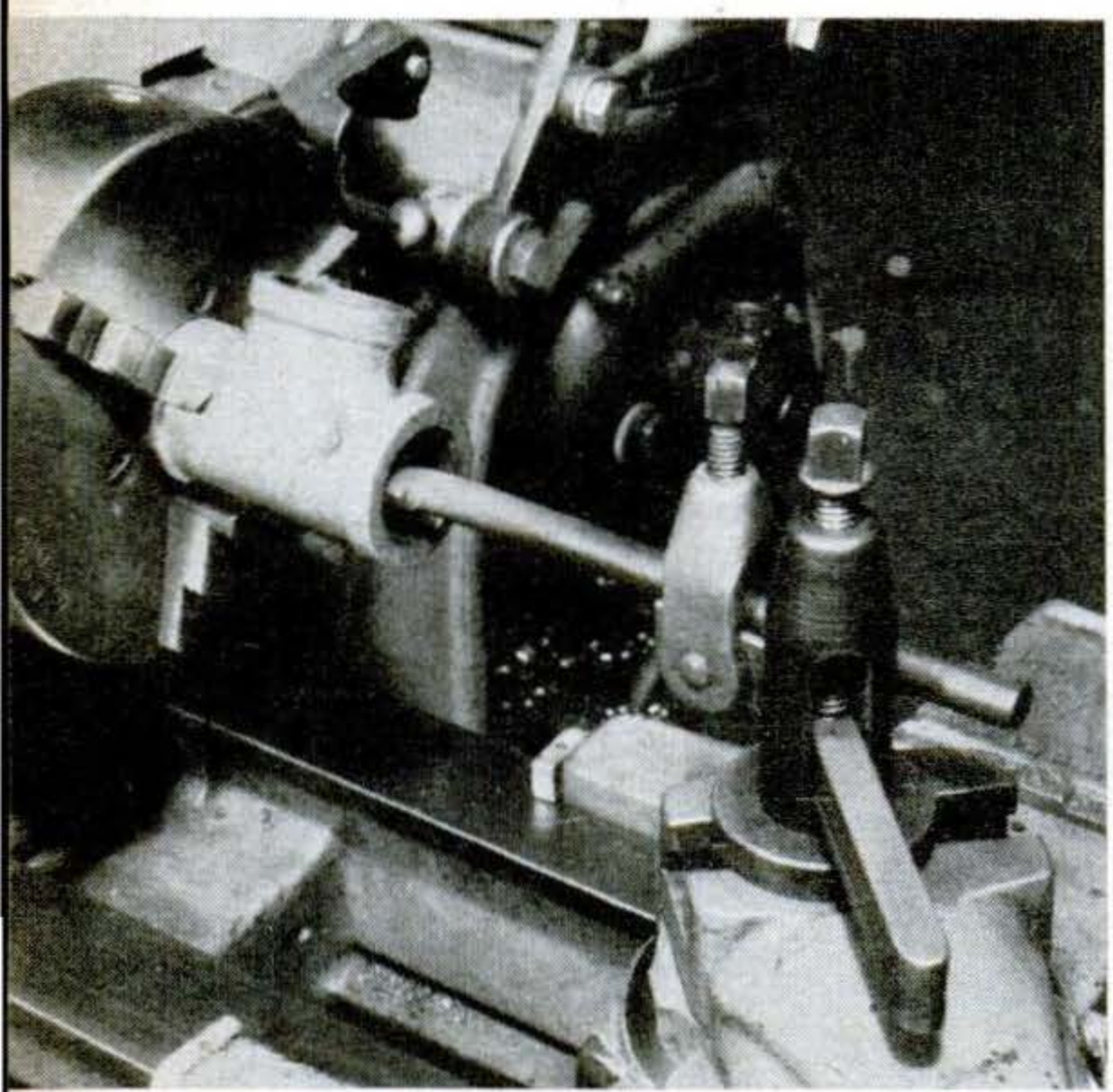
Economical to build, this rigid circular-saw stand was assembled from secondhand ¾" pipe and fittings. Black enamel improves its looks.

Sturdy Shop Stands Built of Pipe

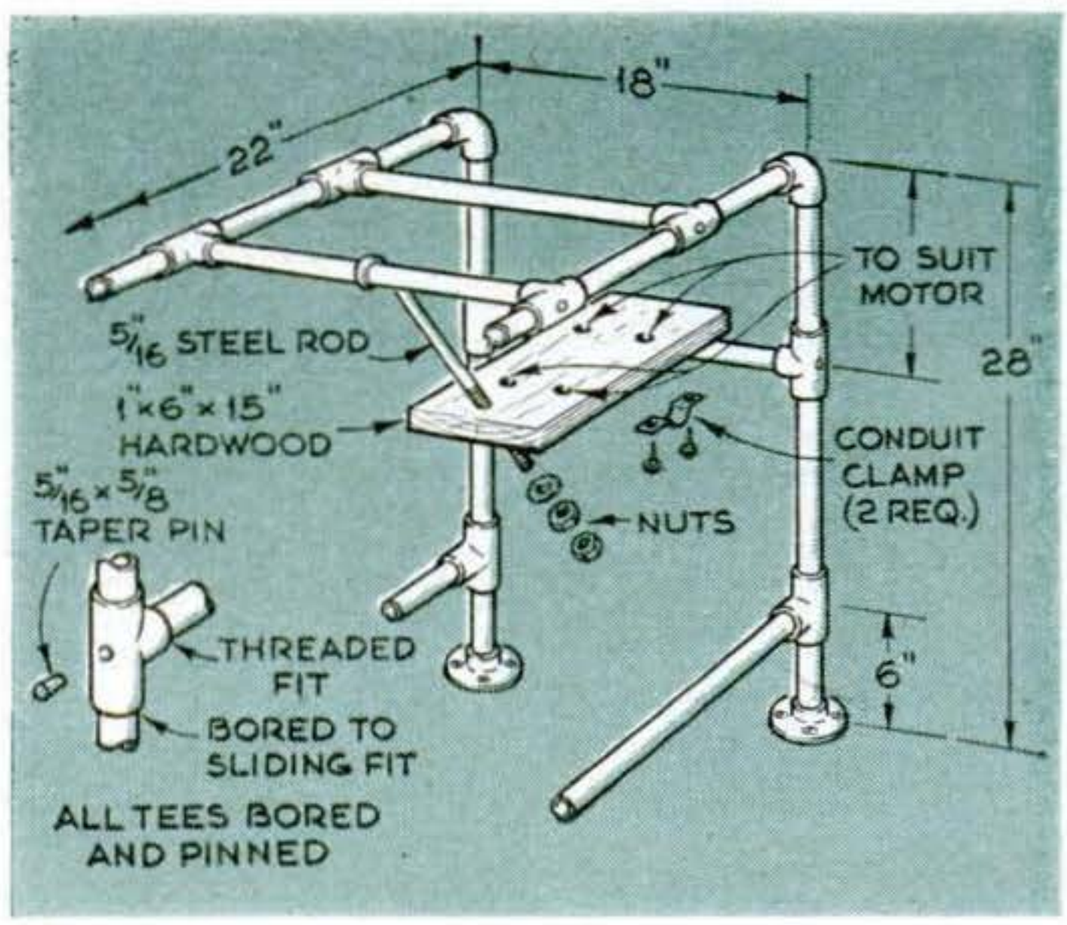
WOBBLY benches and tables have no place in the home shop. You probably know how annoying they can be. Rather than worry along with makeshifts, you can take a tip from the big plants that use benches, tables, and stands made of pipe.

These can be built to any desired size. They are rigid, light, easy to clean, and lasting. By spending a little time looking for used pipe and fittings, you can equip your shop quite economically.

Simplicity is the keynote of pipe construction. Usually the frame can be just a simple boxlike affair. If you buy your materials new, get black pipe and fittings rather than galvanized. The black pipe is less expensive and just as good for this purpose. For light tables and stands, ¾" pipe is amply



Bore out the tees for cross members and fasten with taper pins. The boring job can be done on the lathe with the setup shown above.



Proper belt tension for the circular saw may be obtained by adjusting the hardwood motor support up or down on the 5/16" steel rod.

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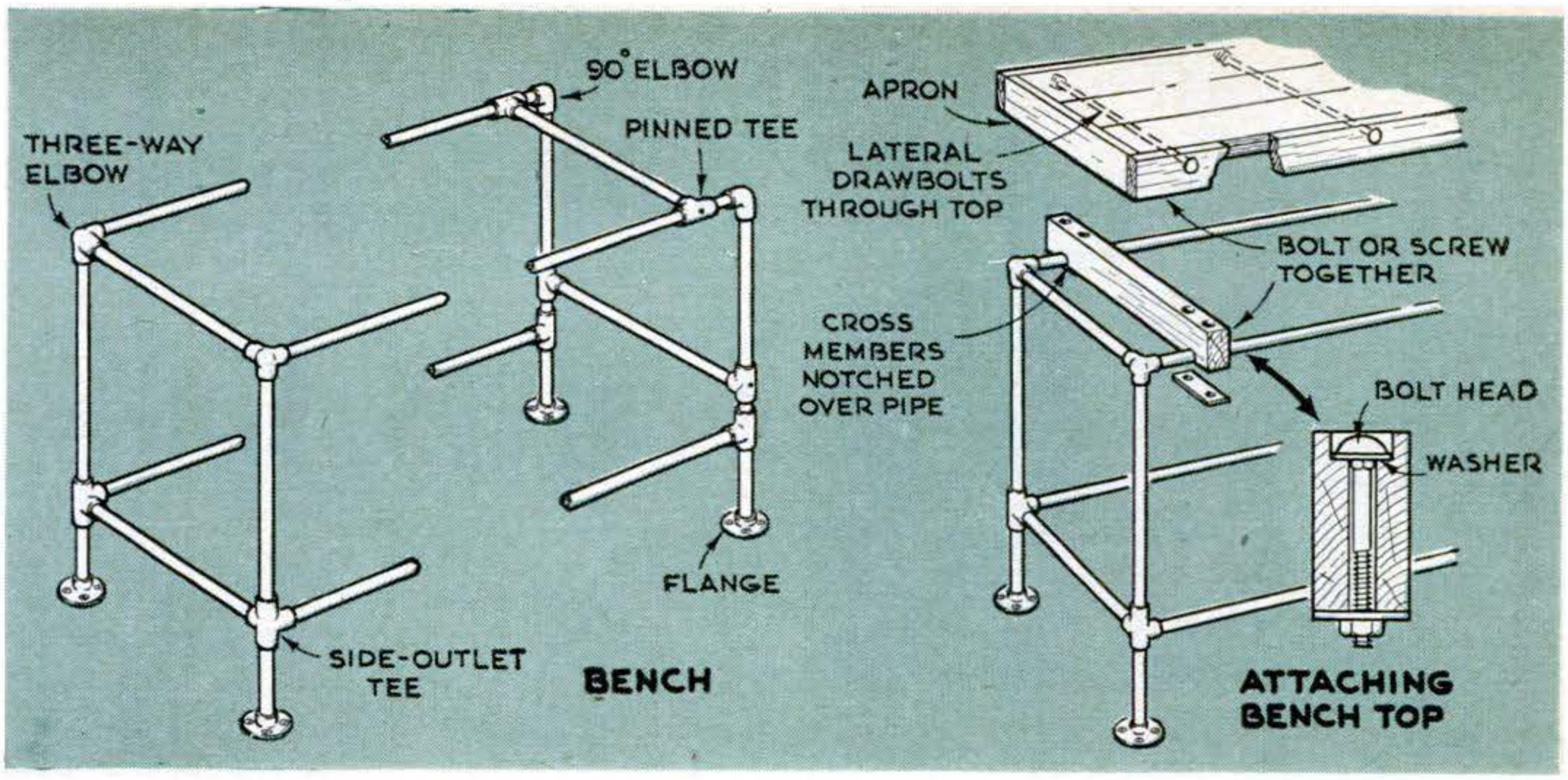


large; but for the heavier tools, better select the 1″ size.

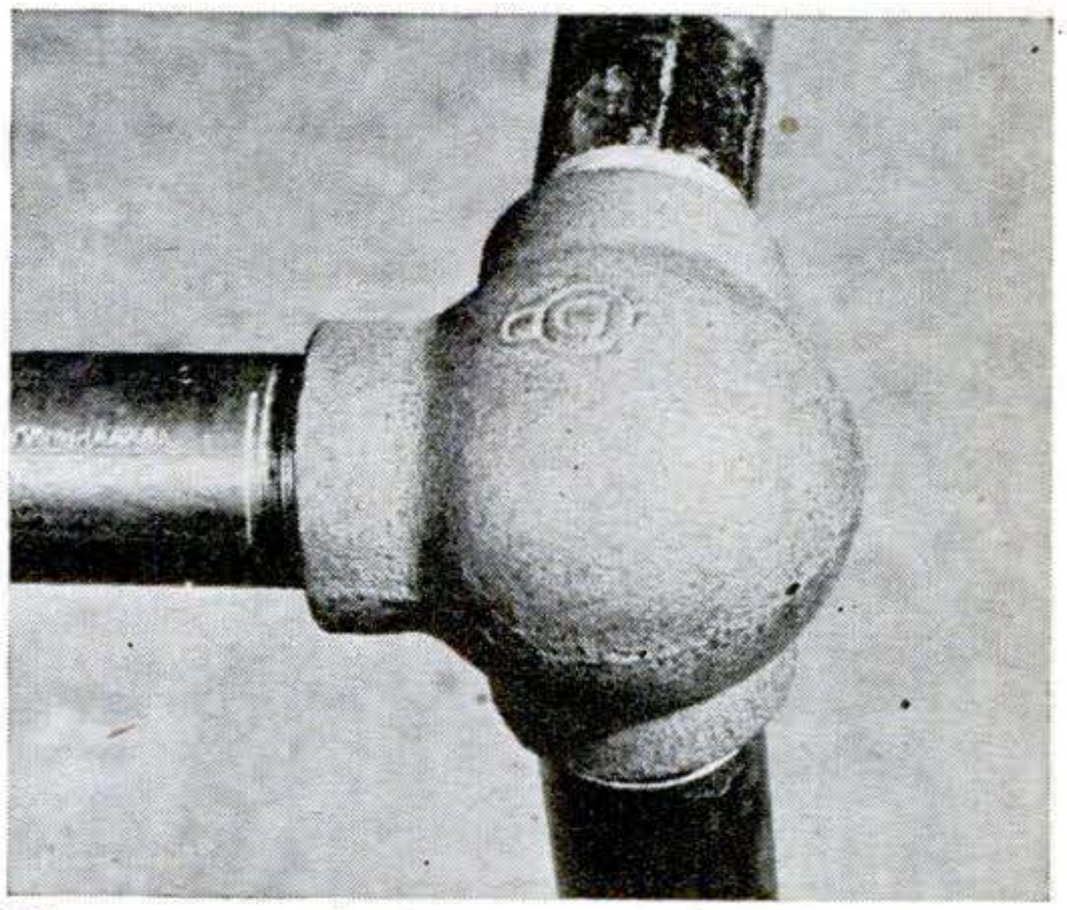
When a straight tee is used on a cross member, bore out the cross to a sliding fit on the pipe. Then secure with a soft-steel taper pin, driven through taper-reamed holes in the tee and pipe. If the stand is likely to be subject to considerable vibration, use bolts instead of pins.

Flanges make excellent feet. If the stand is to be stationary, tighten the flanges firmly and bolt or screw them to the shop floor. Casters can be bolted to the flanges if you want a movable stand.

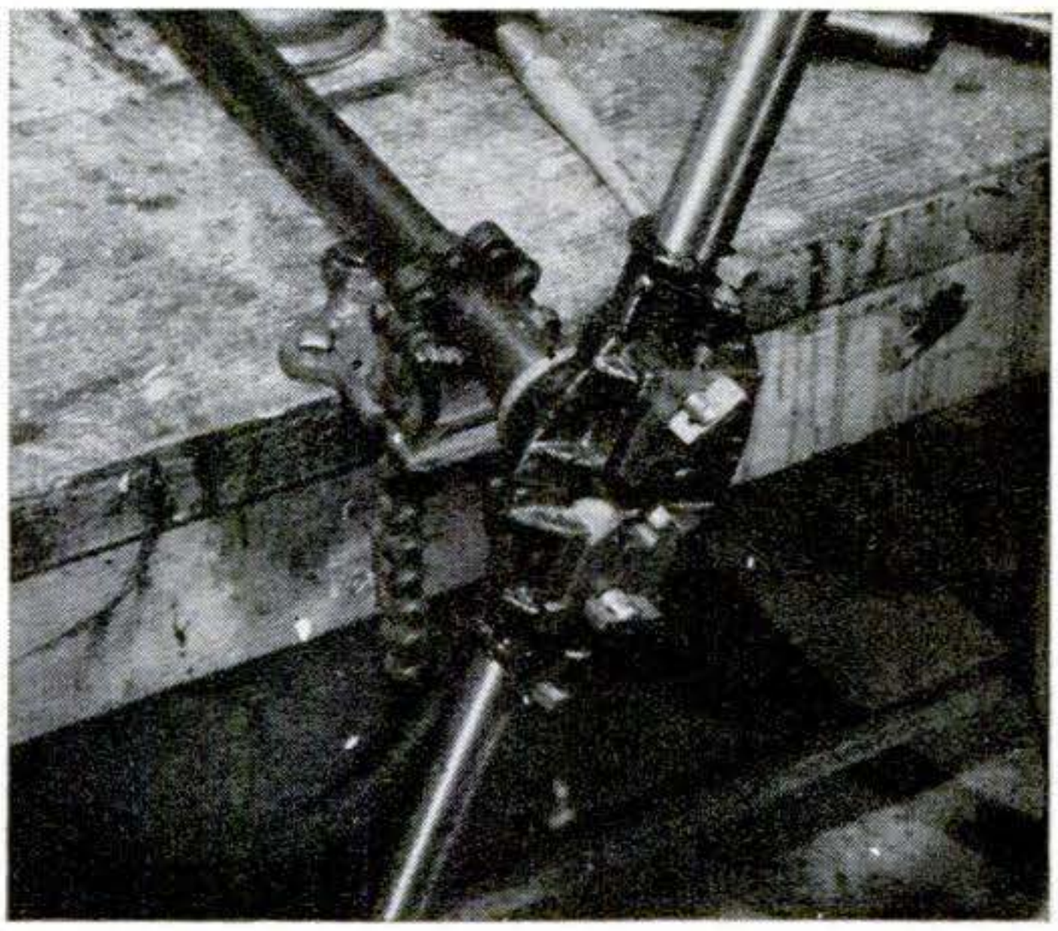
Seasoned hardwood should be used for bench tops. Attach as shown in the above drawing. It's probably best to omit a work surface if the stand is to be used for a small power tool. The stand is easier to keep clean, and mounting the tool base directly on the stand increases rigidity.

Make a diagram of the stand first. This will save you time and prevent waste of pipe. In your plan, be careful to allow for the added height of wooden bench tops or of tool bases. Bench surfaces usually are about 32″ from the floor. Machine-tool stands should bring the tool working surface 36″ to 38″ above the floor.

A pipe vise, cutter, and threading tool are needed. Thread the pipe to take up all the threads on each fitting. Bore out the cross of each tee and drill for a pin. Then make a trial assembly. Mark the pin positions on the pipe. If an electric drill is available, the latter holes can be drilled after final assembly. Otherwise, use a drill press.—*Will Thomas, Kenmore, N. Y.*



Three-way rail fittings are ideal for the top corners. If these are unavailable, you can use ordinary right-angle elbows and tees.



Thread the pipe carefully to take up the full length of threads in each fitting. This gives the stand greater strength and rigidity.

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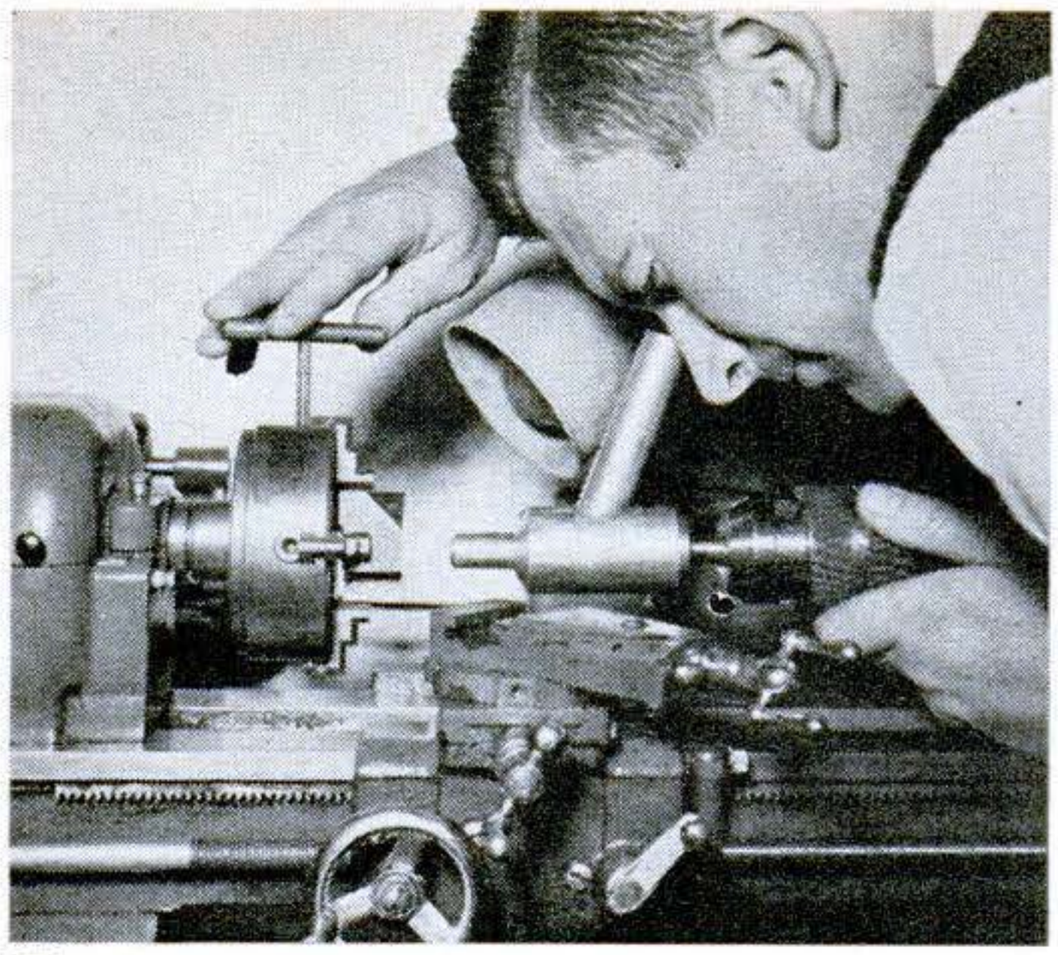


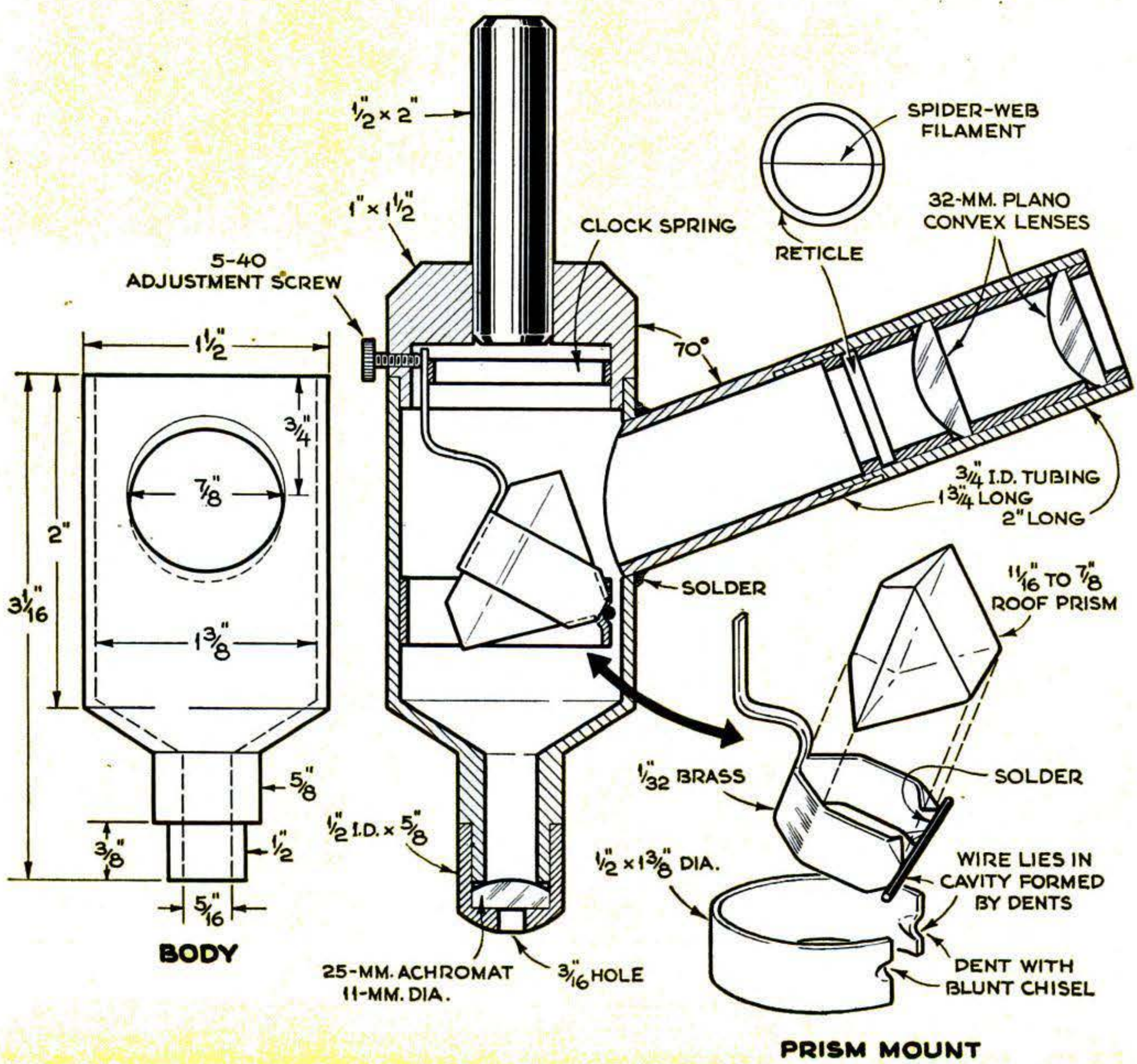
Here's a time and patience saver—a microscope for accurate, visual location of work on lathe or drill press. Above, a four-jaw chuck is adjusted to line up an irregular piece.

Optical Finder Centers Work

THERE'S no guesswork in lining up a job in a four-jaw chuck or on a faceplate or drill-press table when you use a centering microscope. I built this one from brass, using lenses bought from government surplus.

The drawing below gives the principal di-

All parts of the optical finder are shown in the drawing below. Only one joint is soldered.



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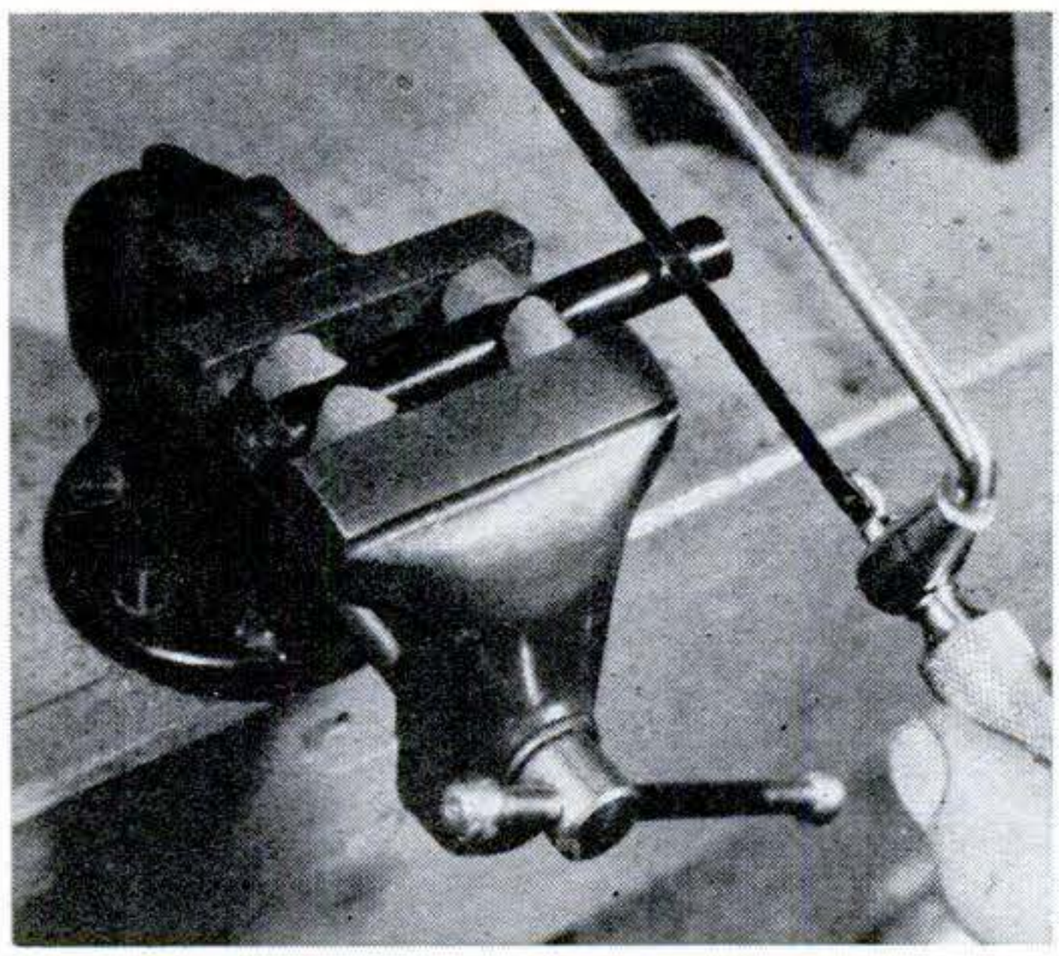
mensions. These, of course, will have to be changed if you use lenses of a different size or focal length. After the body parts have been turned, solder the eyepiece tube in place and coat the inside of both eyepiece and body with dull black lacquer. Next bend the prism holder from 1/32" sheet brass. The size of the forked piece that carries the prism is determined by the size of the prism. Any prism between 11/16" and ⅞" will do.

To mount the prism, place it in the forked carrier and bend the ends of the brass over the edges of the glass. Insert a small piece of chamois between the glass and brass to prevent chipping. The mount then is slid into the body through the top. While doing this, look through the eyepiece tube. Continue pushing until a reflection of the hole where the 25-mm. objective lens will fit appears in the center of the eyepiece tube. Then shift it from side to side to align it. With the exception of the joint between the eyepiece tube and the body, all joints are a light press fit. Make them just tight enough so they are still movable by hand.

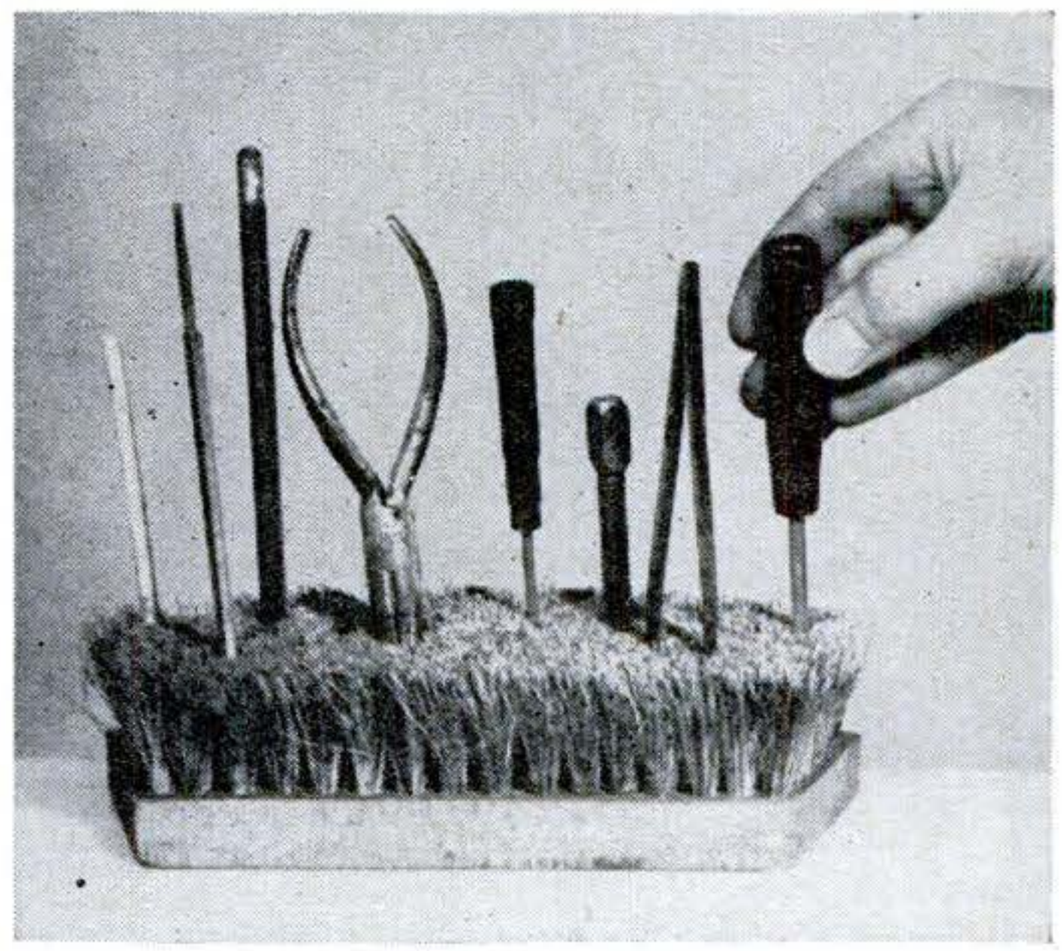
Now set the lenses and reticle in position. The spacing of the 32-mm. lenses and the reticle is important. Mount them first in a cardboard tube to locate the correct relative positions that bring the cross hair into sharp focus.

In use, the microscope is chucked in the tailstock or drill press and advanced until the work is in sharp focus. Adjust the work until the layout mark is centered exactly on the cross hair, rotate the chuck 90 deg. and recenter. If you use a reticle with hairs that cross at 90 deg., just center the layout mark on them and omit turning the chuck.—*Donald Lehr, Audubon, N. Y.*



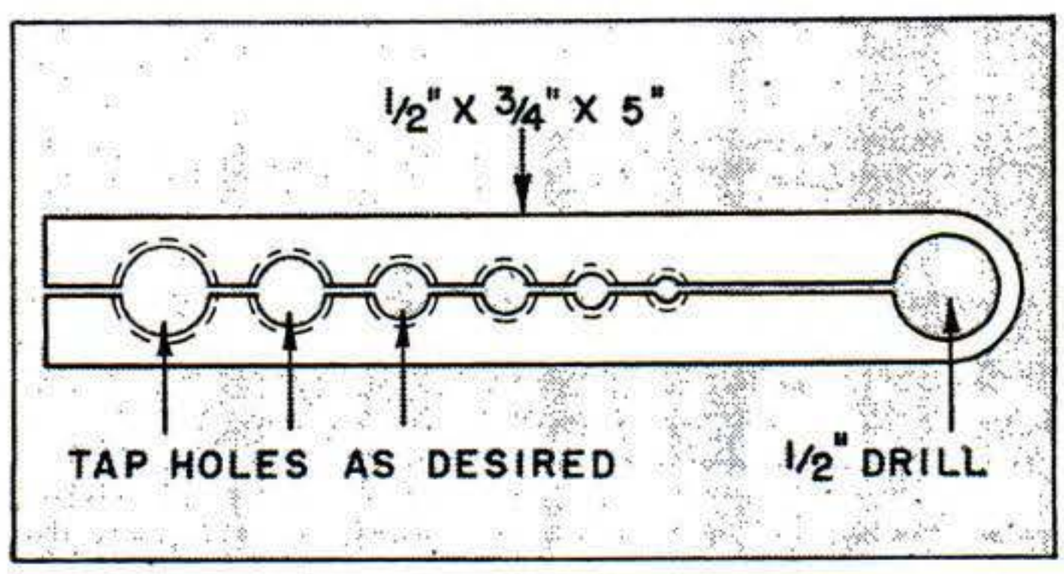
Rubber Hose Holds Plastic Rod

HIGHLY polished plastic rod can be held securely in a vise without marring if it is cushioned by four pieces of stiff rubber hose. Notch one end of the rubber pieces to fit around the rod. They should be just long enough to prevent the vise jaws from touching the plastic.—*W. Thomas, Kenmore, N. Y.*



Brush Is Small-Tool Holder

SMALL files, pliers, screwdrivers, punches, tweezers, gauges, and other pocket-sized tools can be racked conveniently in a stiff-bristled scrub brush. The tools can be easily moved about from job to job and they are always in sight. Such use does not damage the brush.—*H. Leeper, Canton, Ohio.*



Tapped Jig Saves Threads

DRILLED, tapped, and slotted as shown in the drawing at left, a piece of steel forms a jig to hold screws. With it you can slot, square, or cut off screwheads—and do other work on them with a hacksaw or file—without damaging the threads. Put the screw in place and then clamp the holder in a vise.—*M. Duhamel, St. Hyacinthe, Que.*

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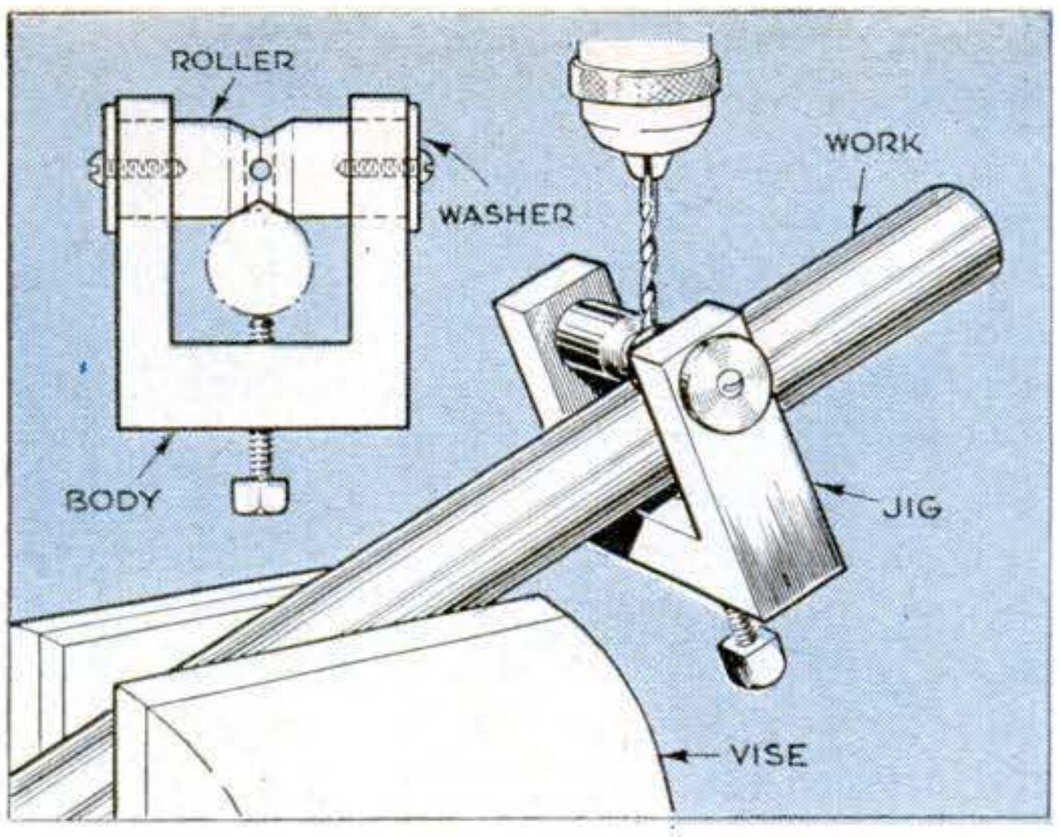
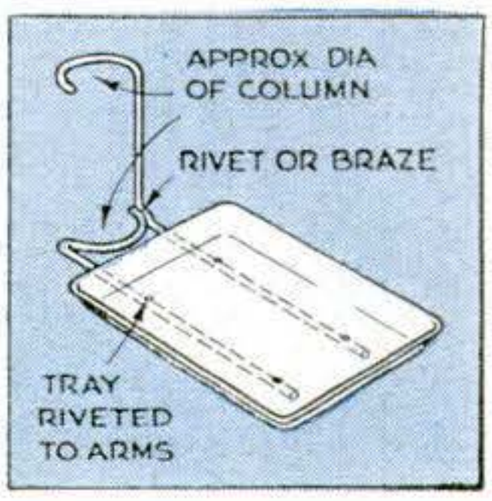
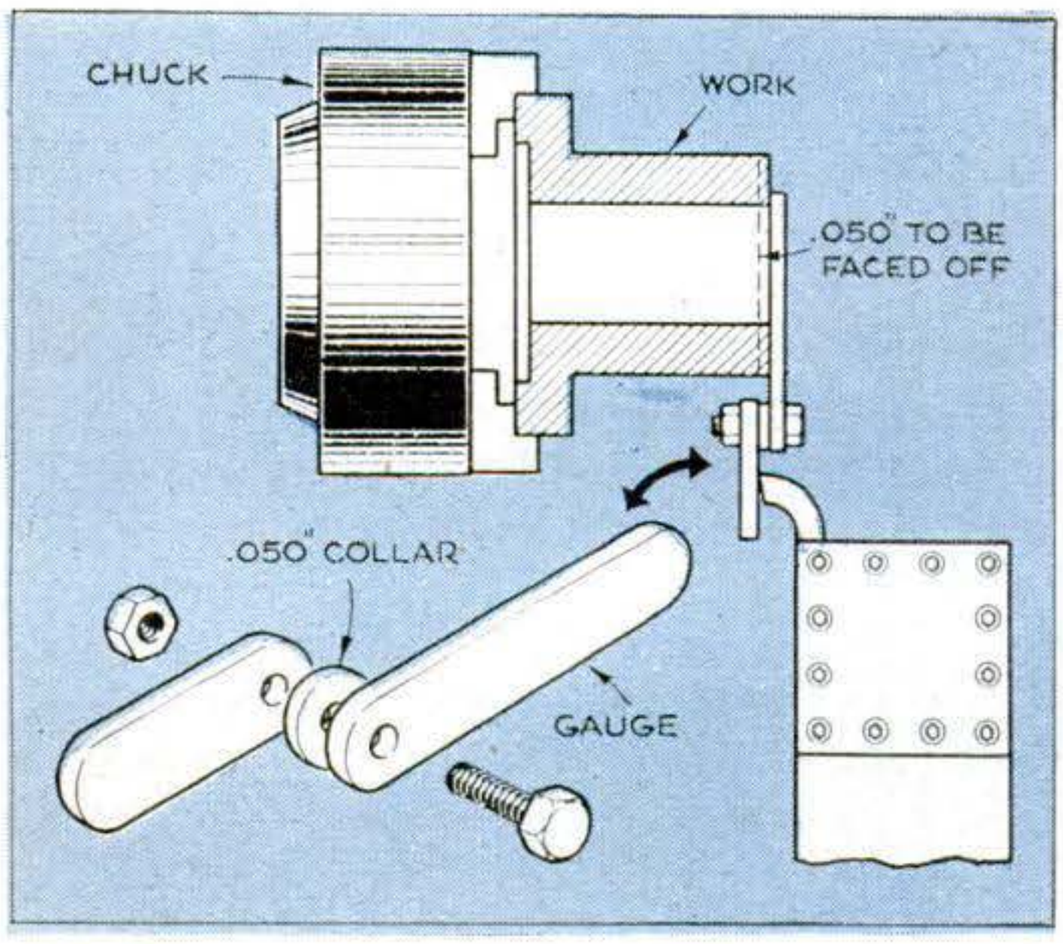


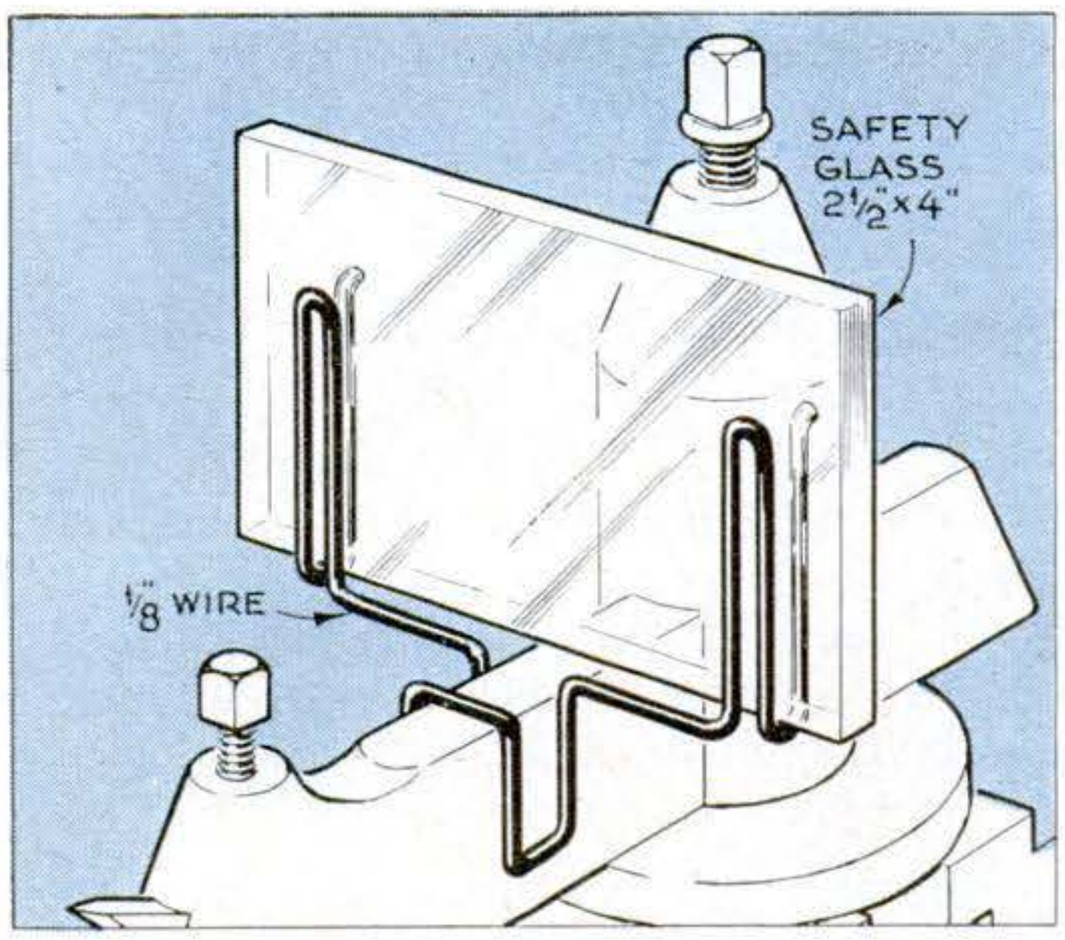
Tray Hooks on Drill Press. Additional materials, tools, and parts are within easy reach of the operator when this tray is used. It slips on or off the press column easily without thumbscrews, clamps, or any other locking device. For the arms you can use Bessemer rod, ½" band iron, or any other metal that can be bent cold. I covered the bottom of the tray—a dime-store cooking pan—with a piece of old rubber bath mat. The supporting arms are covered with rubber tubing.—*Will Thomas, Kenmore, N. Y.*



Angled Holes Drilled with Jig. Making angular holes in a shaft is usually an awkward job without special equipment. This jig, which simplifies the task, consists of a U-bracket cut from solid stock and fitted with a hardened steel roller having a V-groove around the center. Holes of different size are drilled through the V at right angles. Screws and washers hold the roller in place. The jig is clamped on after the work has been set up at the correct angle. A drill is lowered into a hole in the roller, which is free to turn to suit the drill. Then the tightening screw is turned up and the jig guides the drill. If you want a larger hole in the shaft, ream or redrill a pilot hole.—*H. Moore, Leeds, England.*



Making Accurate Face Cuts. When you want to face off a fixed amount on repeat work, the gauge shown here permits a fast, accurate setup. The collar thickness can of course be varied to suit the job. In use, one arm of the gauge is positioned against the face of the work and the other against the bit.—*Charles Schoen, Detroit.*



Shield Stops Chips. I don't like to wear a face shield at the lathe but I dislike hot, flying chips even more. So I bent up a framework of wire to hold a piece of safety glass (you could use clear plastic) and mounted it just behind the tool bit. It may be slipped off or on quickly.—*John L. Sanders, Ray, Ariz.*

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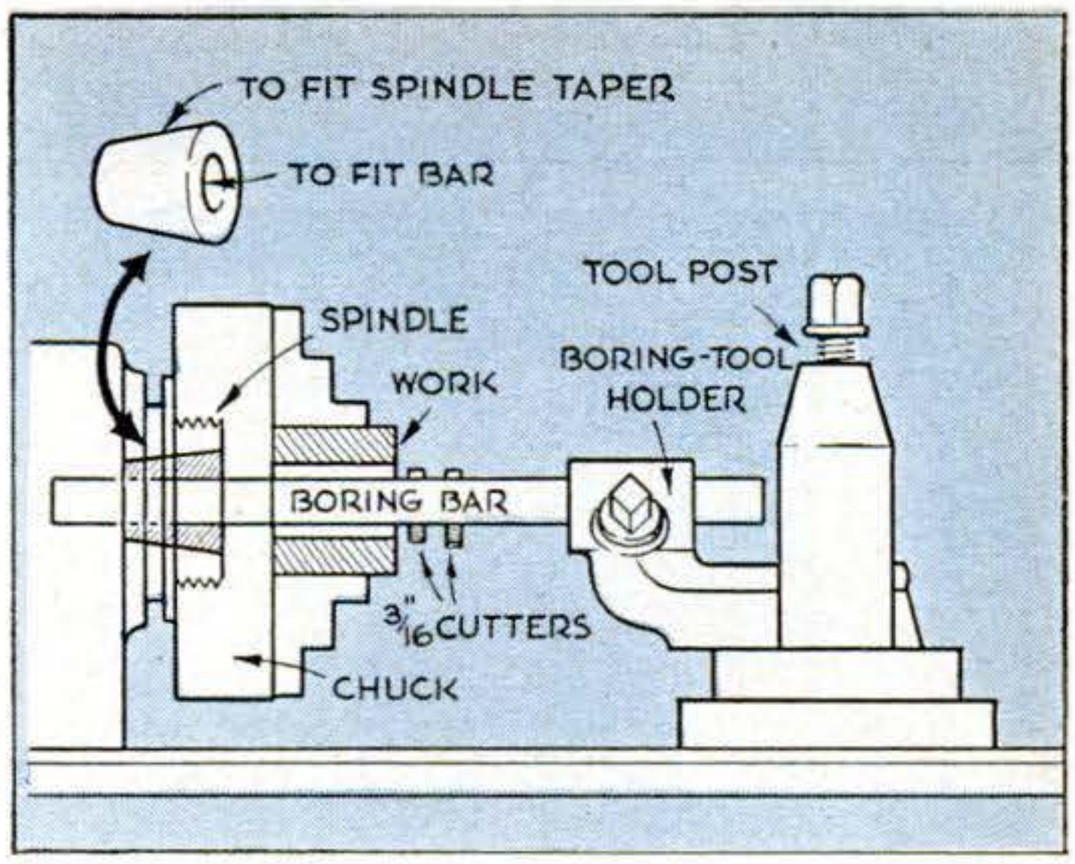
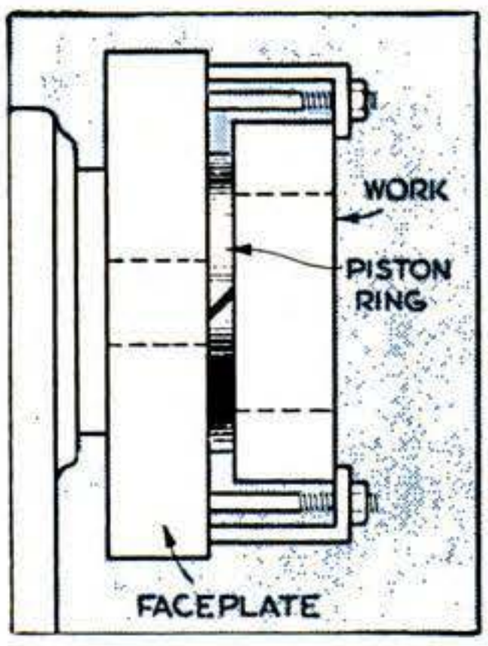
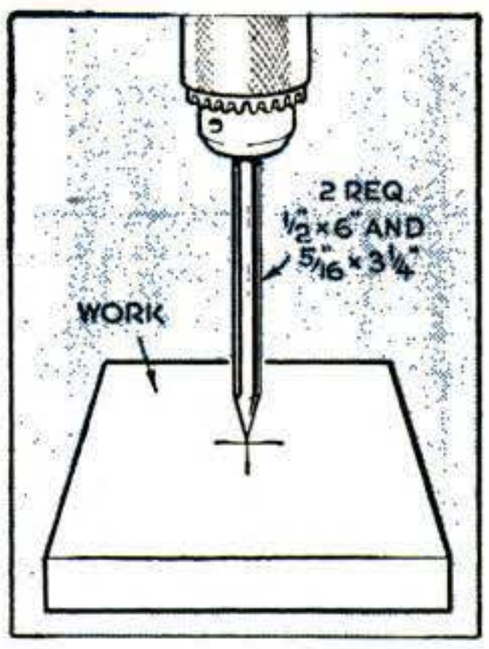
Boring Tool Speeds Work. The boring tool shown at right carries two cutters —one roughing and one finishing. I use it on bearings and any casting with cored holes, and find that it eliminates tool chatter, allows a heavier cut, and consequently speeds production. The tapered sleeve shown in the sketch may be made of either cast iron or bronze. This tool is adaptable to any size of lathe by making the sleeve taper to fit the spindle and the bar to fit the boring-tool holder. Heavier bits, of course, would be used with larger bars. —*Harry Morris, Bronx, N. Y.*



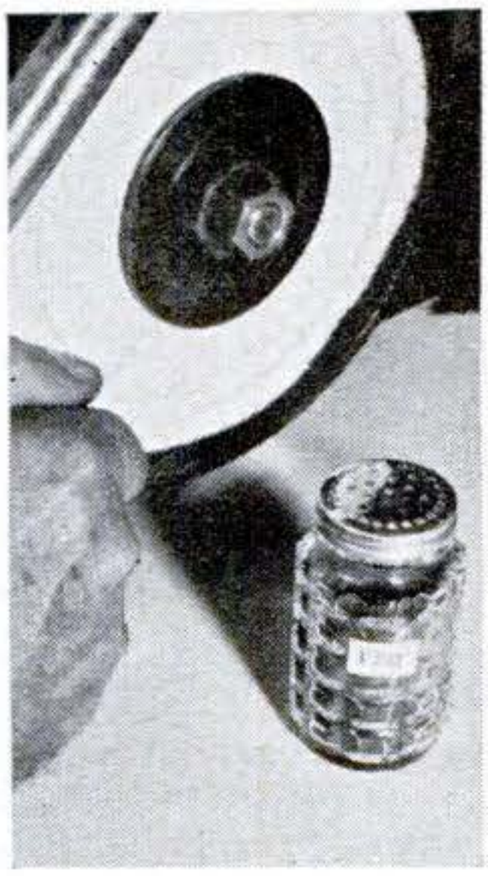
Piston Ring Spacer. On boring jobs where the hole is larger than the hole in the faceplate, packing must be used to keep the boring tool from striking the faceplate. I've found that a piston ring—a new one, if possible—is better than anything else. A piston ring is not as likely to fall out of place, as so often happens when setting up a job with several pieces of packing.—*W. A. Welland, Victoria, B. C.*



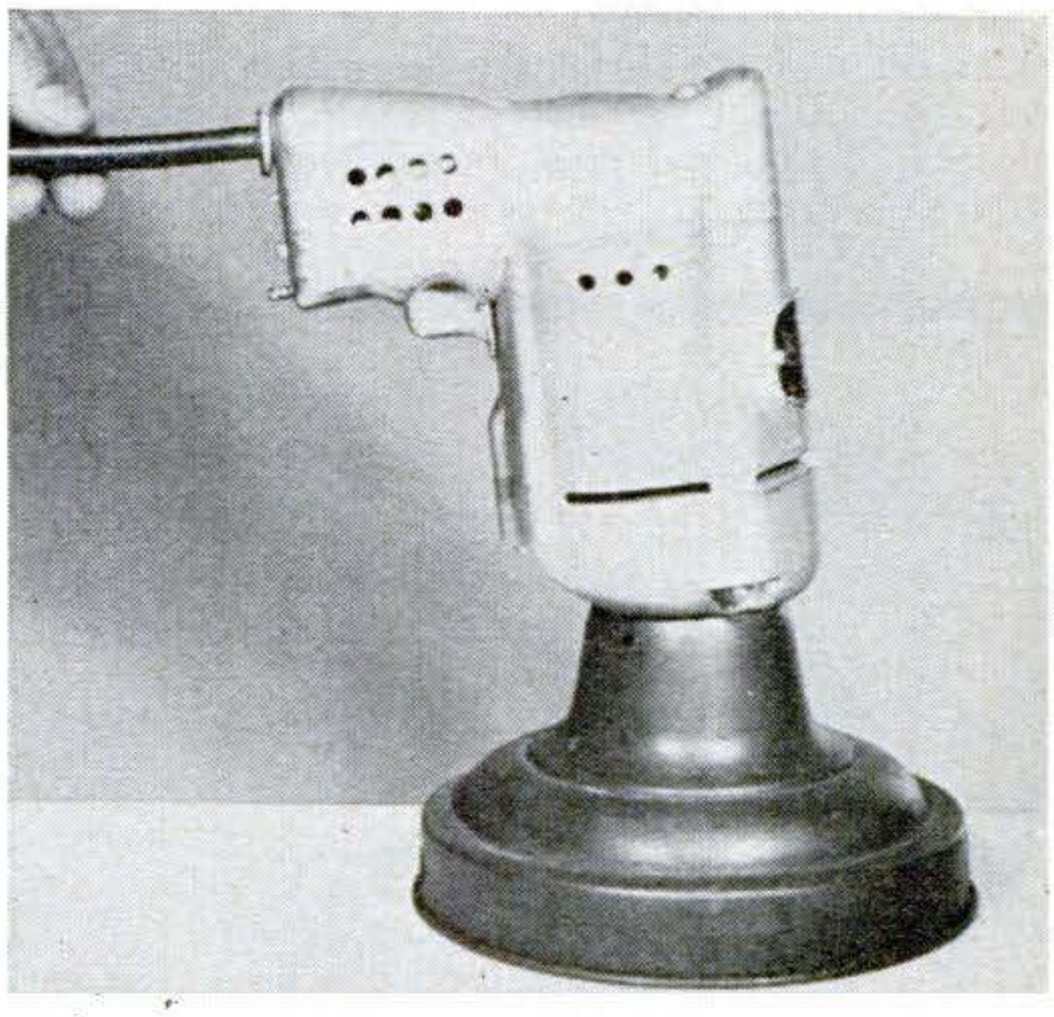
Center Finders. These two center finders, turned from brass rod, are a help in locating work precisely on a drill-press table. For holes up to ⅜", chuck the smaller one. The larger one is more in proportion for larger drills. With a finder in the chuck, locate the punch mark on the work directly under it. Clamp the work down, recheck the location, and replace the finder with a drill.



Dressing Grinding Wheels. A piece of broken, rod-type heating element from an electric stove can be used to true grinding wheels. Bits of the smaller units are particularly suited for wheels used on lathe grinders. Pass the end of the broken element lightly over the face of the revolving wheel as you would use a commercial dresser.



Abrasive Powder Dispenser. Dime-store salt shakers are economical dispensers for abrasive powders used in lapping and polishing. They work efficiently, help you save powder, and because of their size and shape are easy to store. Label each shaker with the type of abrasive and the grain number.



Fixture Base Holds Drill. A metal light-fixture base is a fine holder for an electric drill. A ceiling canopy may also be used. Cut off to fit the chuck of the drill, and screw it down to your workbench.—*H. Leeper, Canton, Ohio.*

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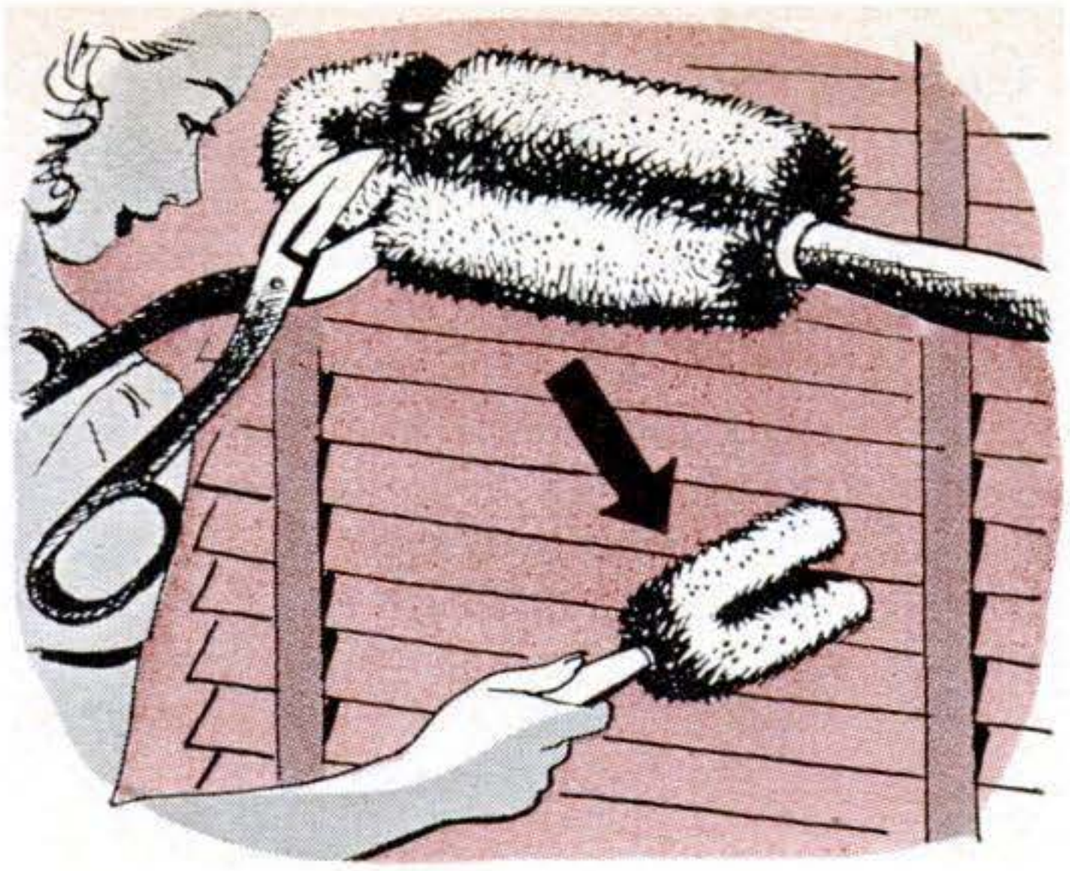
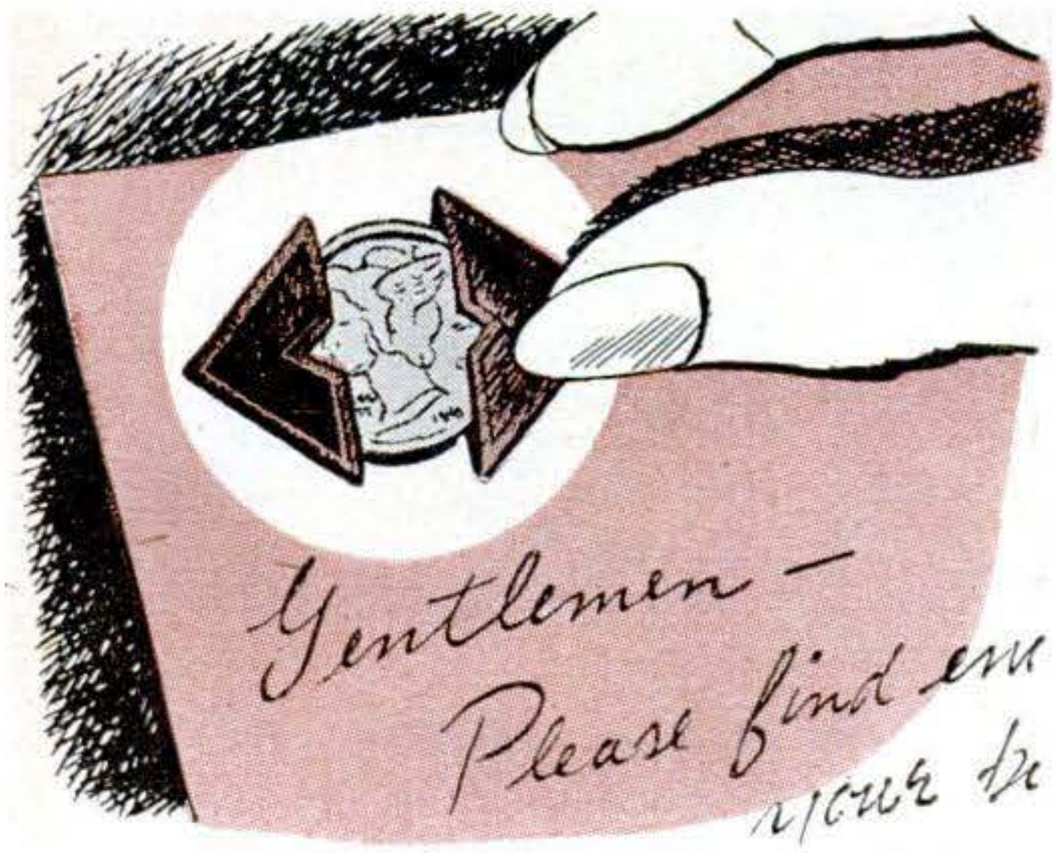
Keeping the Home Shipshape

To add variety to lunch boxes, include frozen fruit. Break off enough from a package for a serving and put it in a small jar. By mealtime, the fruit will have thawed enough to eat.

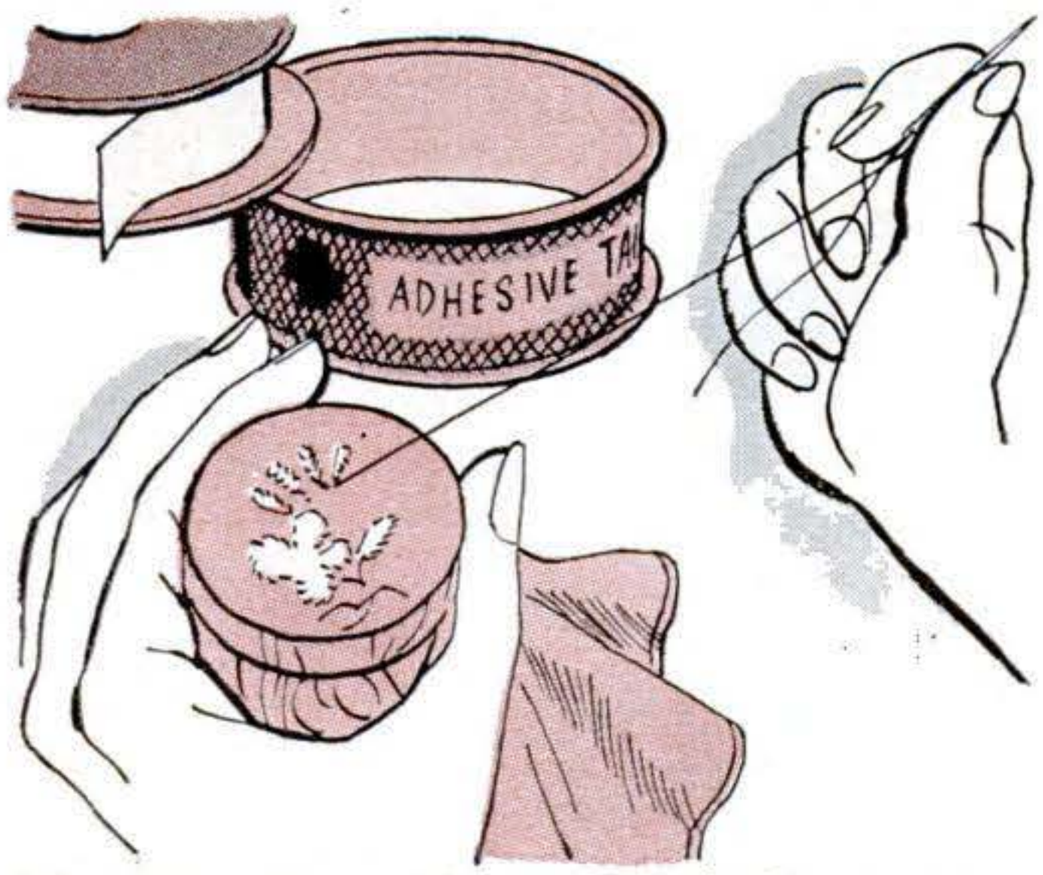


A Venetian-blind duster can be made from any soft brush with twisted-wire backing by snipping off the rounded end. Cover the cut ends of wire with tape to prevent scratches.

Rolling up extra piecrust in waxed paper before putting it away in the refrigerator, instead of storing the dough in a lump, saves time and muss when you are ready to use it.



To mail a coin with a letter, slip opposite edges of it into two gummed corners—the kind sold for mounting photographs—and stick them down on the face of your letter.



The cover from a large roll of adhesive tape makes a small hoop for embroidery or darning. Pull the material taut over the opening and secure it with a rubber band around the hoop.

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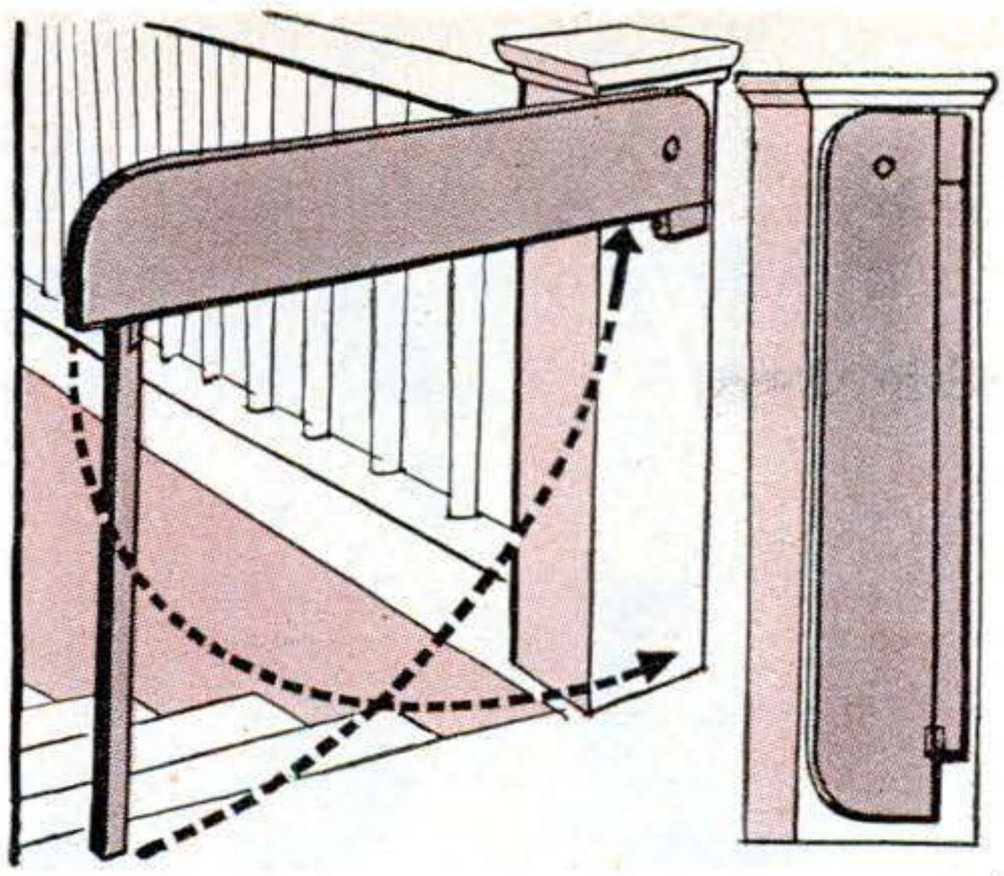
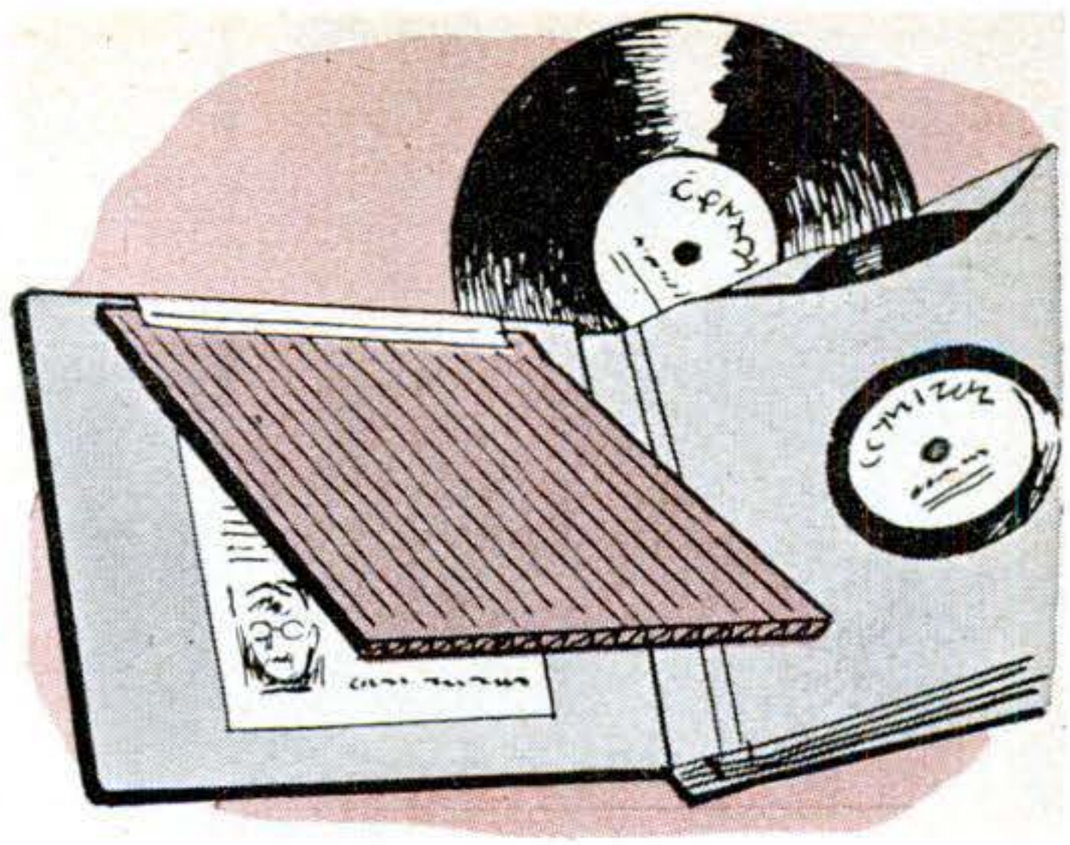
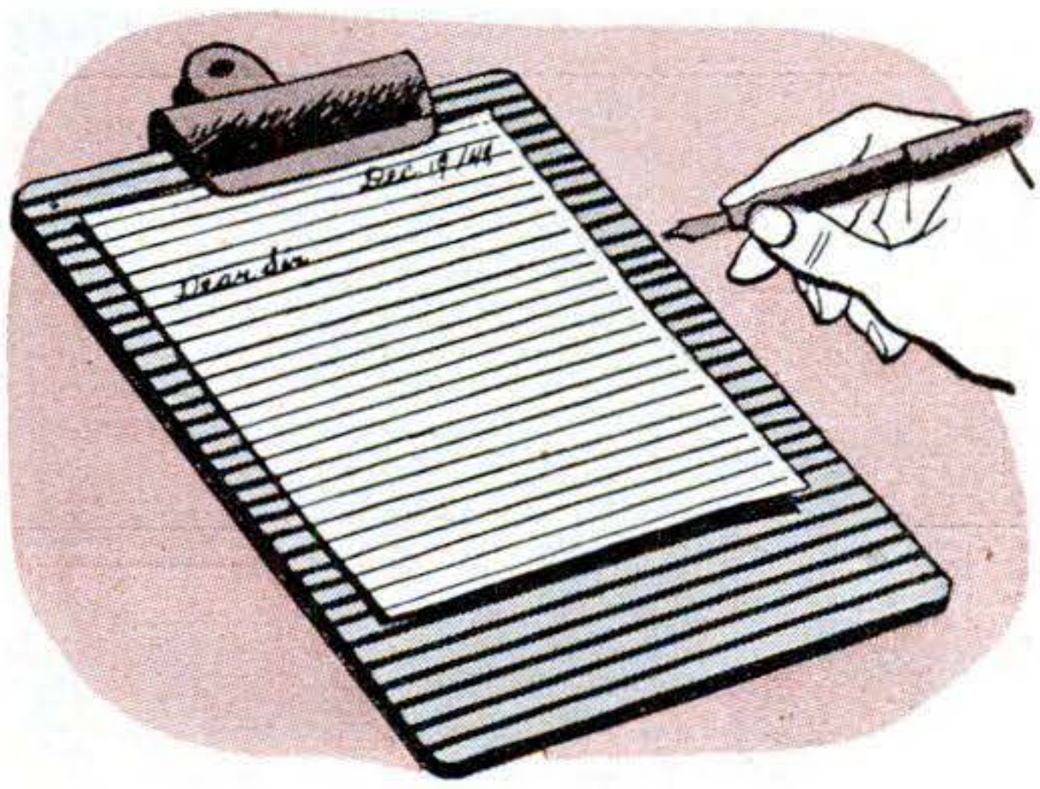


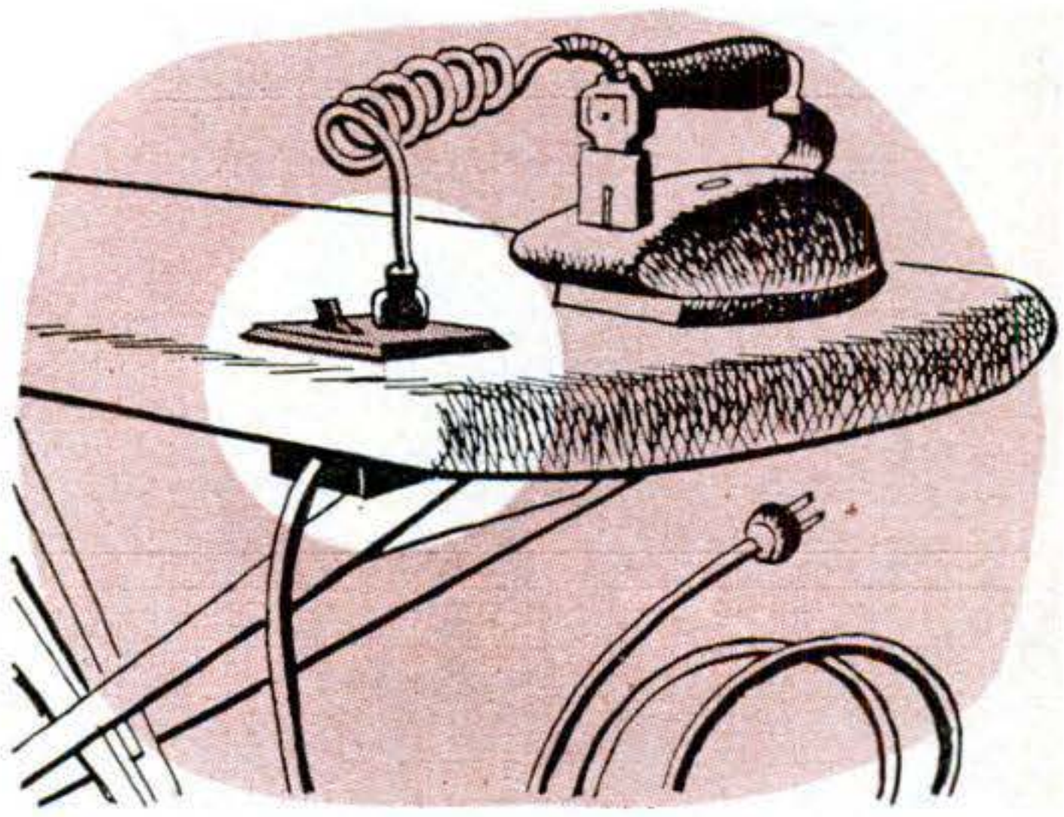
This safety gate prevents falls downstairs by serving as a reminder in the dark. Supported by a single bolt and hinged leg, it folds away, and a cupboard catch then holds the leg up.



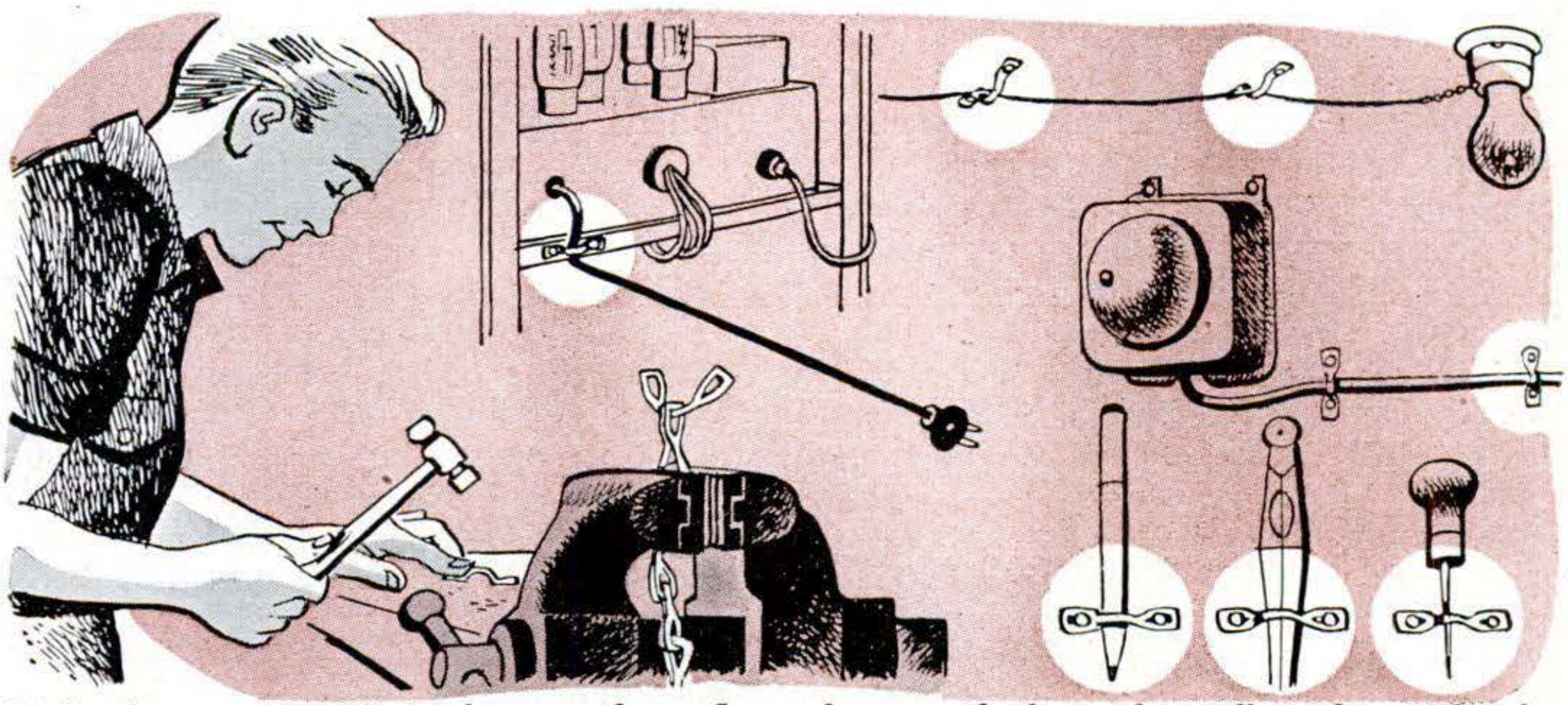
For added protection to record albums, tape the cardboard liners that come in them to the inside covers. Leaving the front one loose at the bottom lets you lift it to read program notes.



With this doctored-up clip board, you can write in straight, evenly spaced lines on unruled stationery. Guide lines in India ink on a flat-white background show through the paper.



An electrical outlet on an ironing board keeps a housewife from tangling herself in the cord. A box underneath is easier to install, requiring no hole, but is not quite so handy to use.



Links from a sash chain, hammered out flat and then arched, can be used as line-cord anchors, guide loops for pull cords, staples for low-voltage wiring, and wall clips for small tools.

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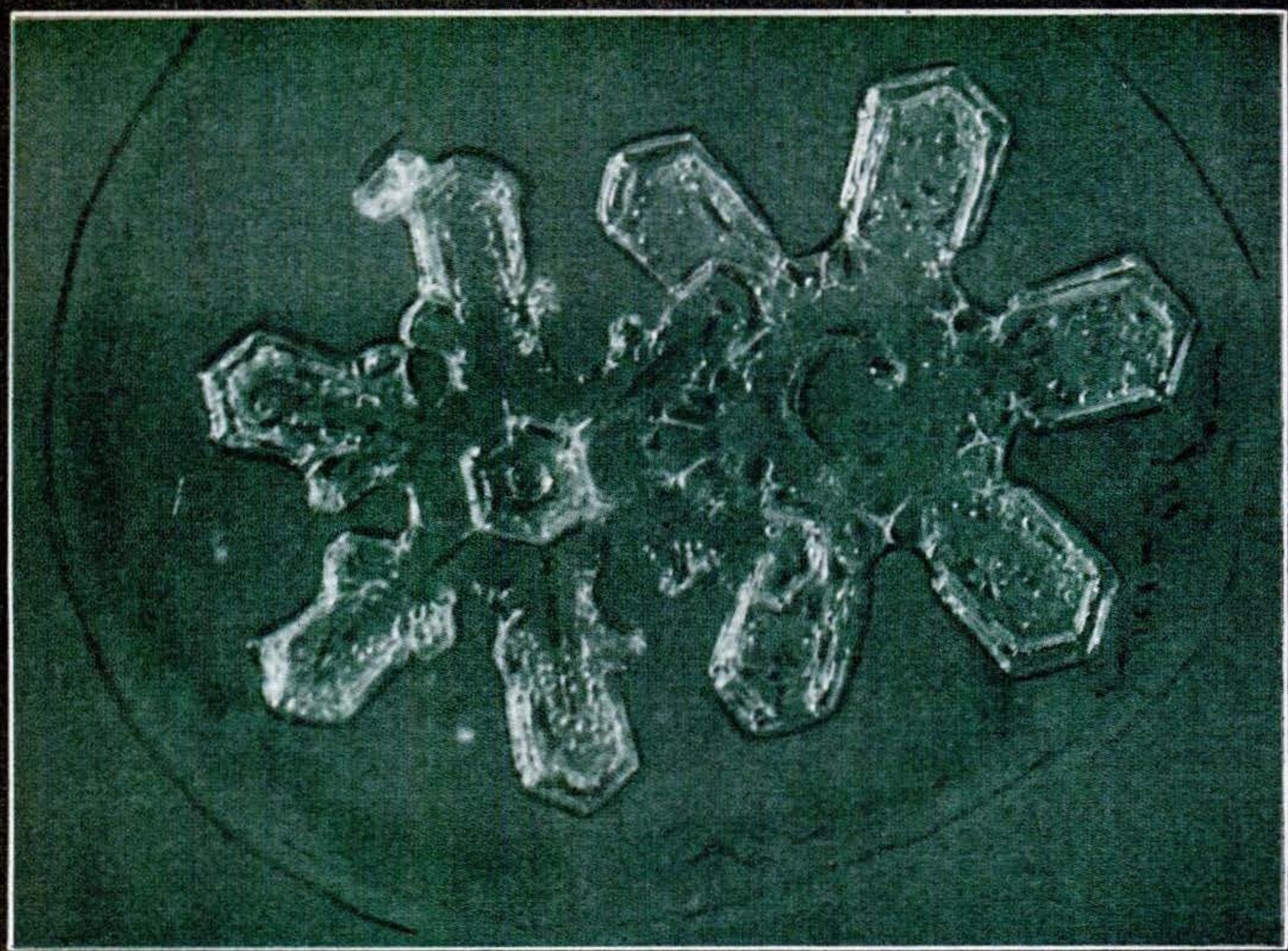

Sealing Snowflakes in Plastic

WAY BACK in 1898 POPULAR SCIENCE published the first report of the work of William Bentley, the self-educated Vermont scientist who pioneered snowflake photography. Bentley's dramatic pictures of the delicate crystals—snapped the hard way with bulky equipment out in the cold—are still widely reprinted. Now a modern "snowflake scientist," also self-educated, has invented a method of capturing flakes so that they can be studied in a comfortably heated room.

Vincent J. Schaefer, the General Electric chemist who created the first man-made snow, has developed a process for preserving the shape of snow crystals in plastic. His surprisingly simple method is shown in the step-by-step photographs on the facing page. It imprisons the snowflake in a transparent polyvinyl plastic resin called Formvar 19-95® that spreads to extremely thin films—only about one molecule thick. This plastic, used industrially as an electric insulator, quickly hardens around the snowflake. The snow evaporates through the plastic shell, but leaves behind an impression that duplicates the original.

These plastic replicas can then be examined and photographed at leisure through a microscope to reveal all the intricate beauty of snow crystals. Typical of the results possible is the picture above, reproduced from a color original Schaefer made of a rare "Siamese-twin" snowflake. The same method preserves other frost crystals, such as "breath patterns." These can be made without waiting for a snowstorm by simply blowing on a chilled plate covered with the liquid plastic, and then putting the plate in a refrigerator.

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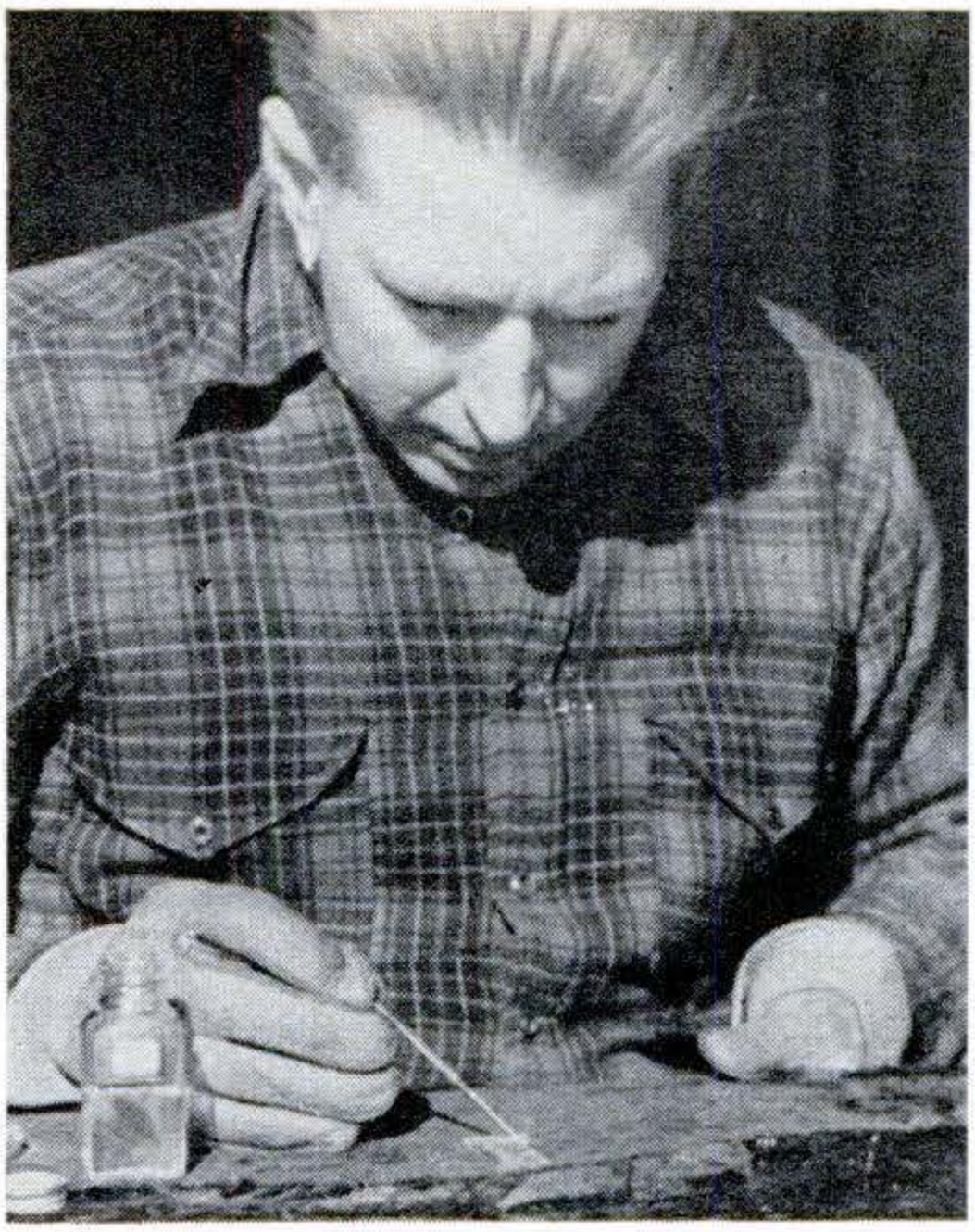
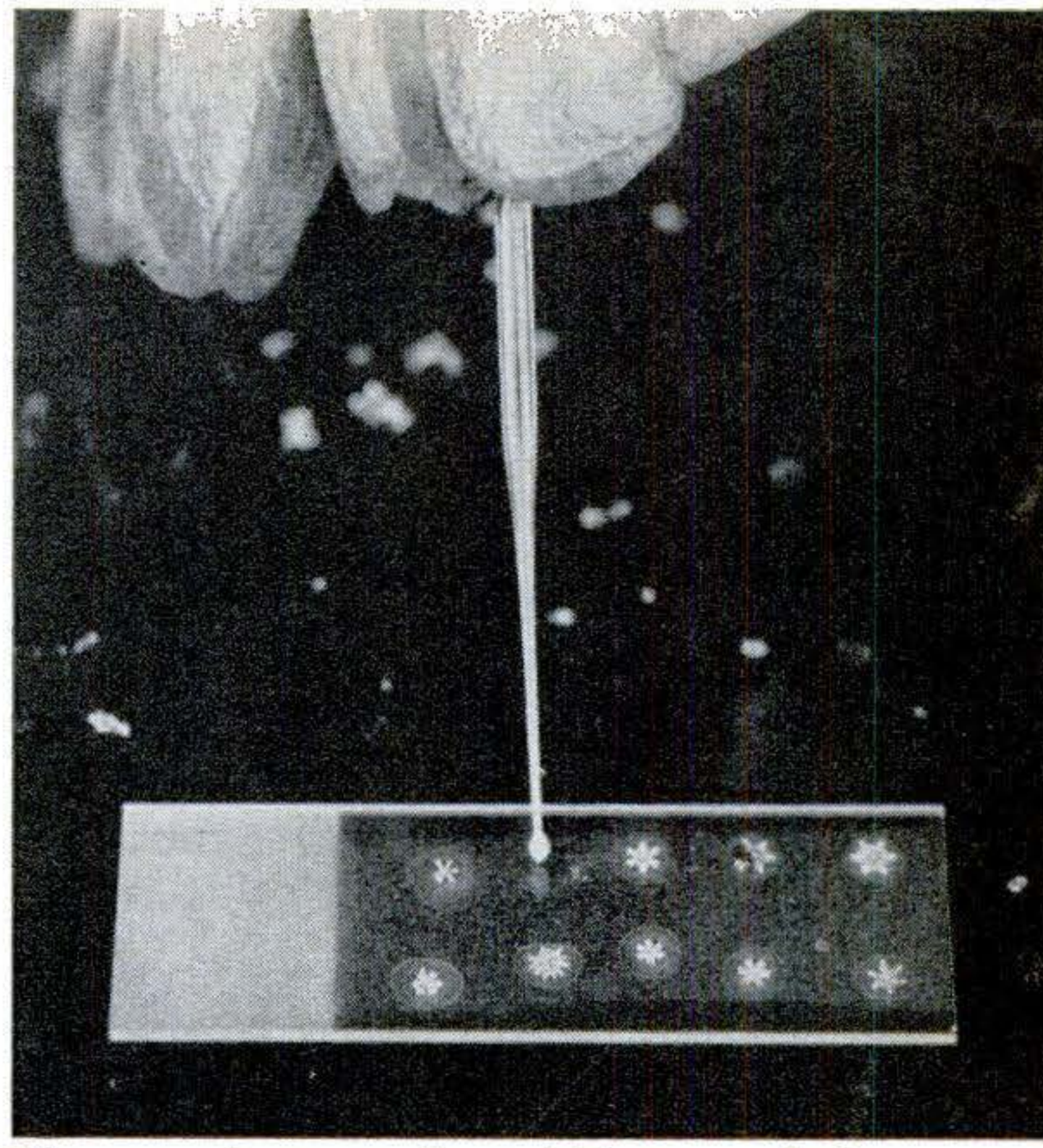
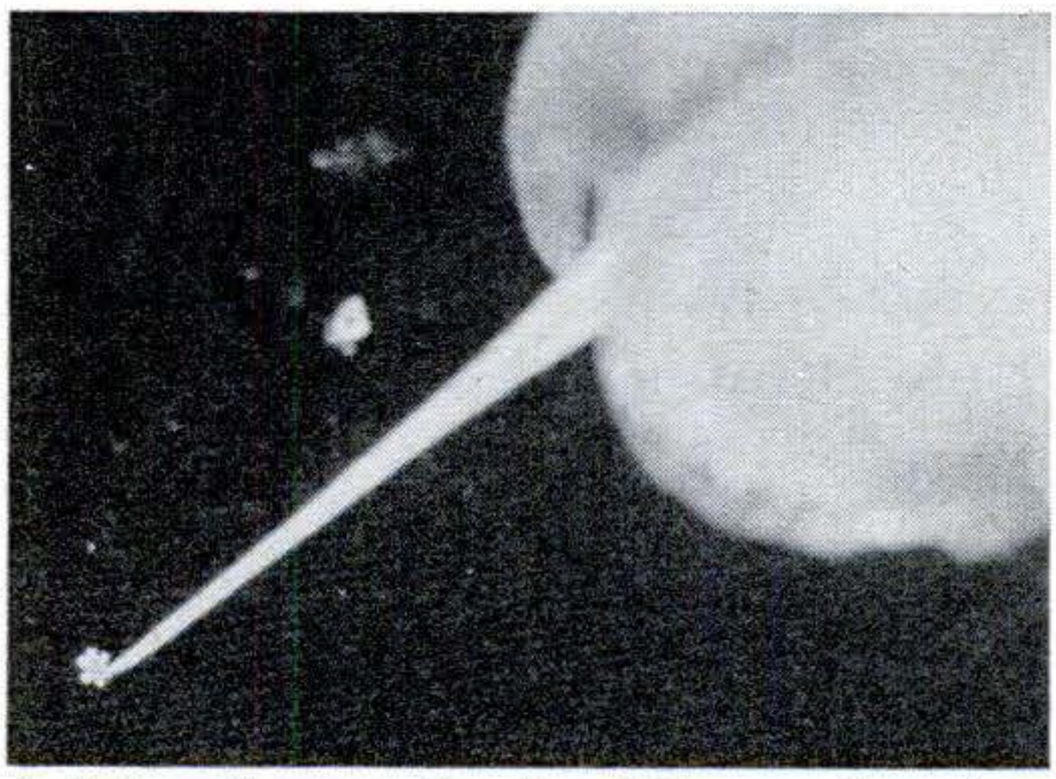


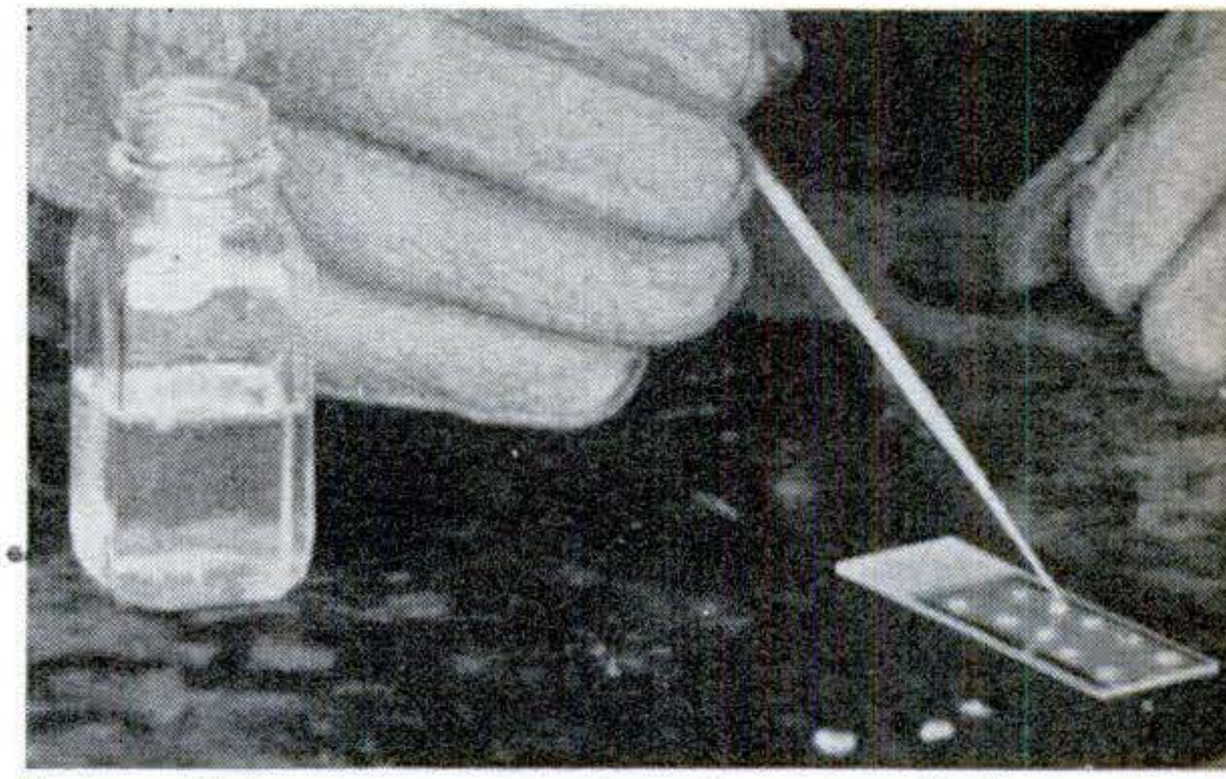
Schaefer shows how to preserve snowflakes with a piece of black velvet, a slim glass rod, a glass slide, Formvar dissolved in ethylene dichloride to make a 1-percent solution—and snow.



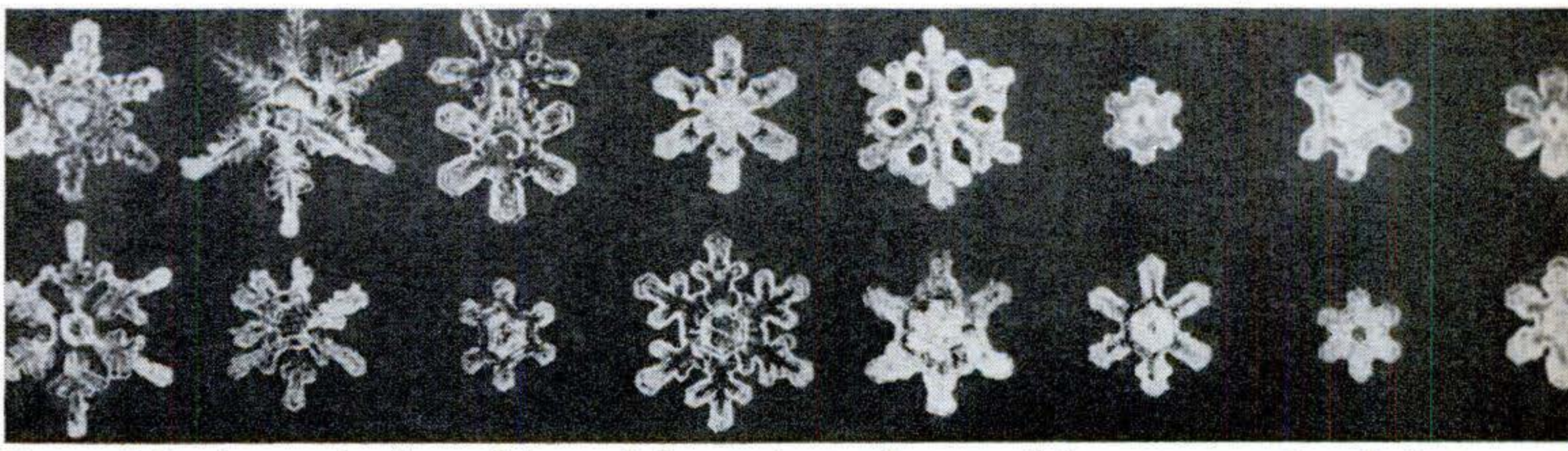
First step is to put drop of Formvar solution, which has been cooled below 32 deg. in ice-cube compartment of refrigerator, on the chilled glass slide. Velvet improves visibility.



A flake of snow that has fallen on the velvet is then picked up with rod and quickly transferred to the drop of plastic. The plastic should wet the snowflake completely.



Large flakes are covered with a second drop of plastic. Steps must be completed quickly, for the solvent evaporates fast. Once hard, the plastic-encased snowflake can be taken indoors.



Some of the thousands of snowflakes sealed in plastic and photographed by Schaefer are shown above. Prettiest flakes are star shaped, but plate, rod, and other different forms are found.

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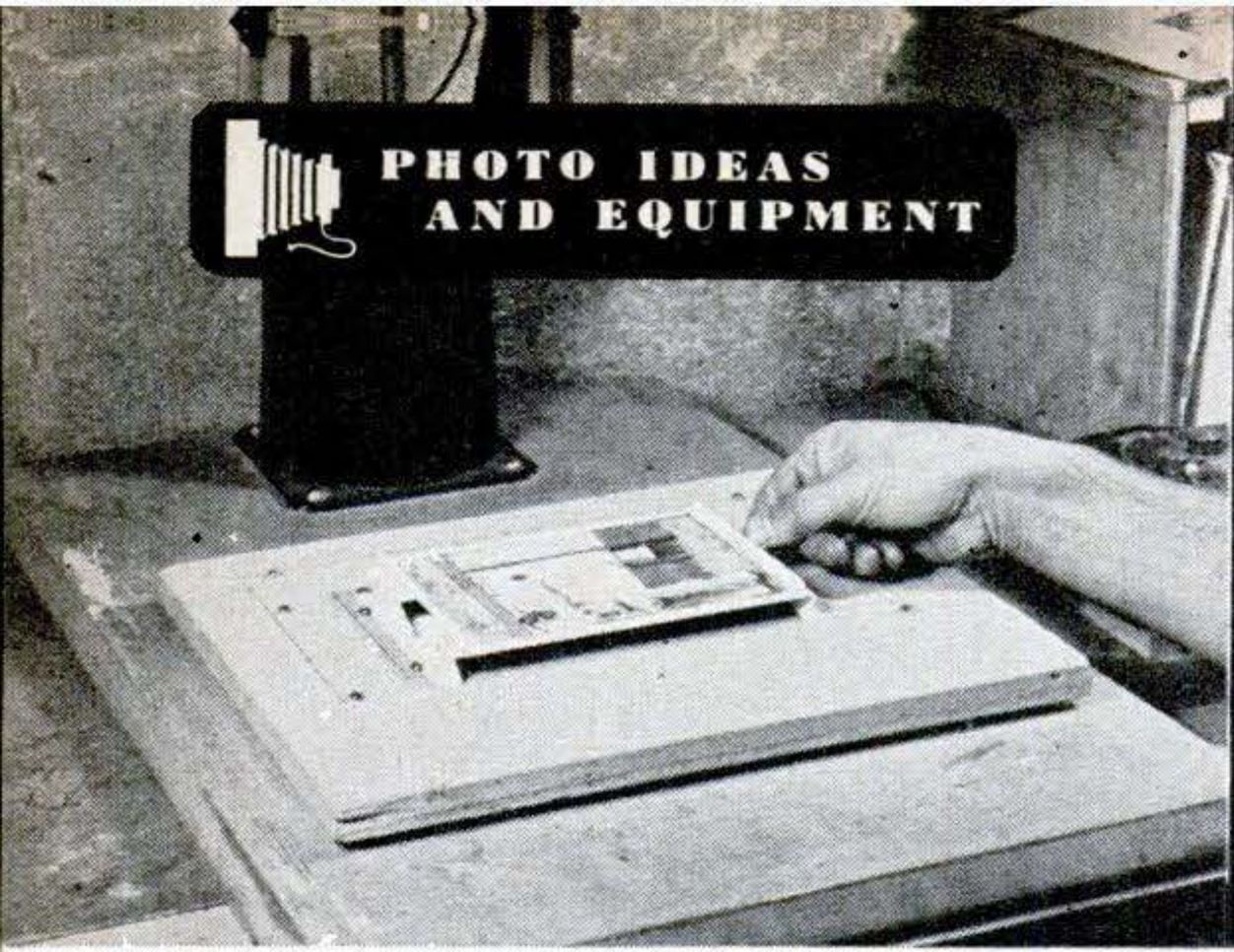
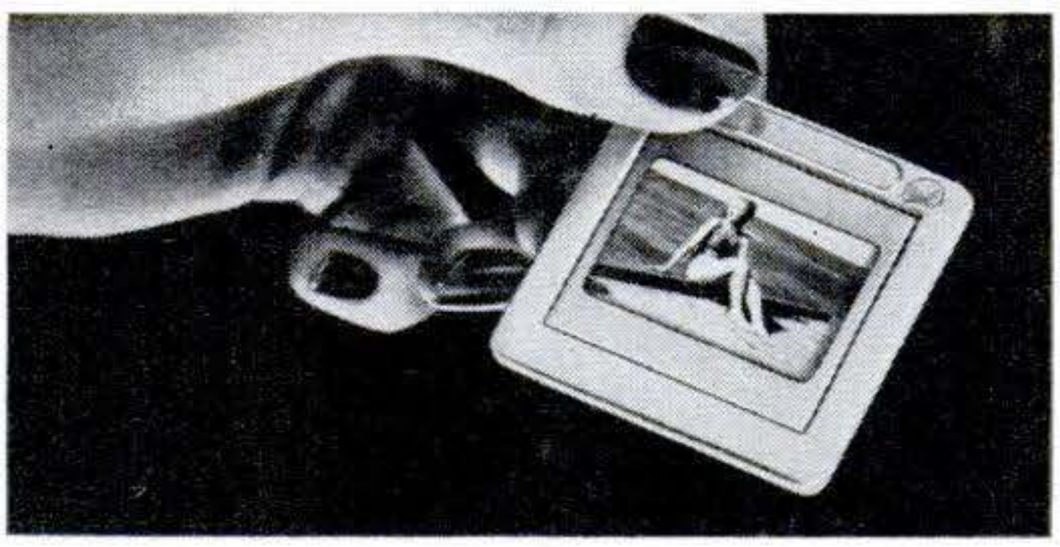


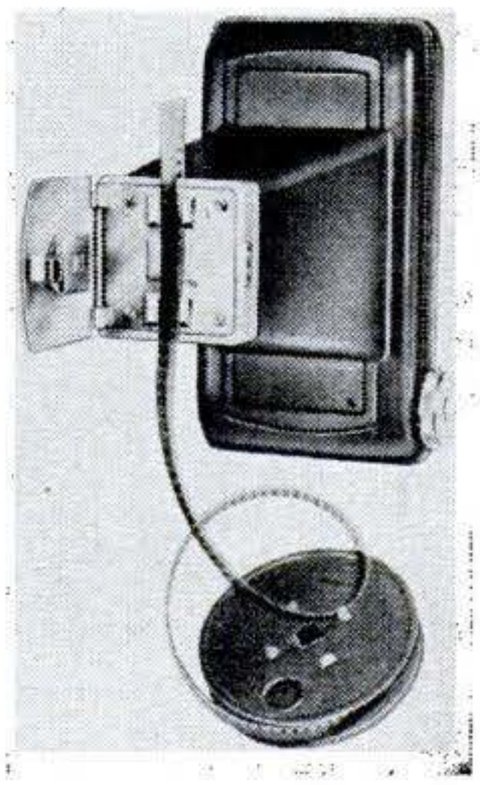
Wood Base Anchors Easels. Unless you're careful, the fixed-margin metal easels now popular with photographers may be pushed out of position when you're inserting paper after focusing. Here's a way of overcoming the difficulty. It consists of a 12″ by 15″ sheet of plywood with ½″ round-head wood screws to hold easels of different size. The screws are turned in just far enough to catch the lips of the easels. Ink lines give a quick location of each easel size.—*R. Hertzberg, Jackson Heights, N. Y.*

New Camera Has Fade Control. A feature of a new 8-mm. movie camera introduced by the DeJur-Amsco Corp., Long Island City, N. Y., is a Fade-Matic Control®. This device permits you to fade out one scene and fade in the next, eliminating jerky, unrelated sequences. Fading is controlled by the button seen above the lens barrel. The model above comes with either a f/2.5 or f/1.9 lens. A turret model is also offered.



New Binder Snaps Shut. Here's a quick way of mounting 35-mm. transparencies for projection. You simply place the transparency between the two pieces of glass and snap the aluminum covers shut. It's made by GoldE Manufacturing Co., Chicago.

Makes Stills from Movies. A camera for making stills from movie film has been introduced by the Testrite Instrument Co., New York. Called a Cinelarger®, it uses 620 film which, after exposure, is developed and printed in the usual way. One roll gives 16 negatives from 8-mm. film, eight from 16-mm. size. In use, a photoflood bulb is placed 12″ from the lens and the shutter opened for 25 to 60 sec. Price is about $19.



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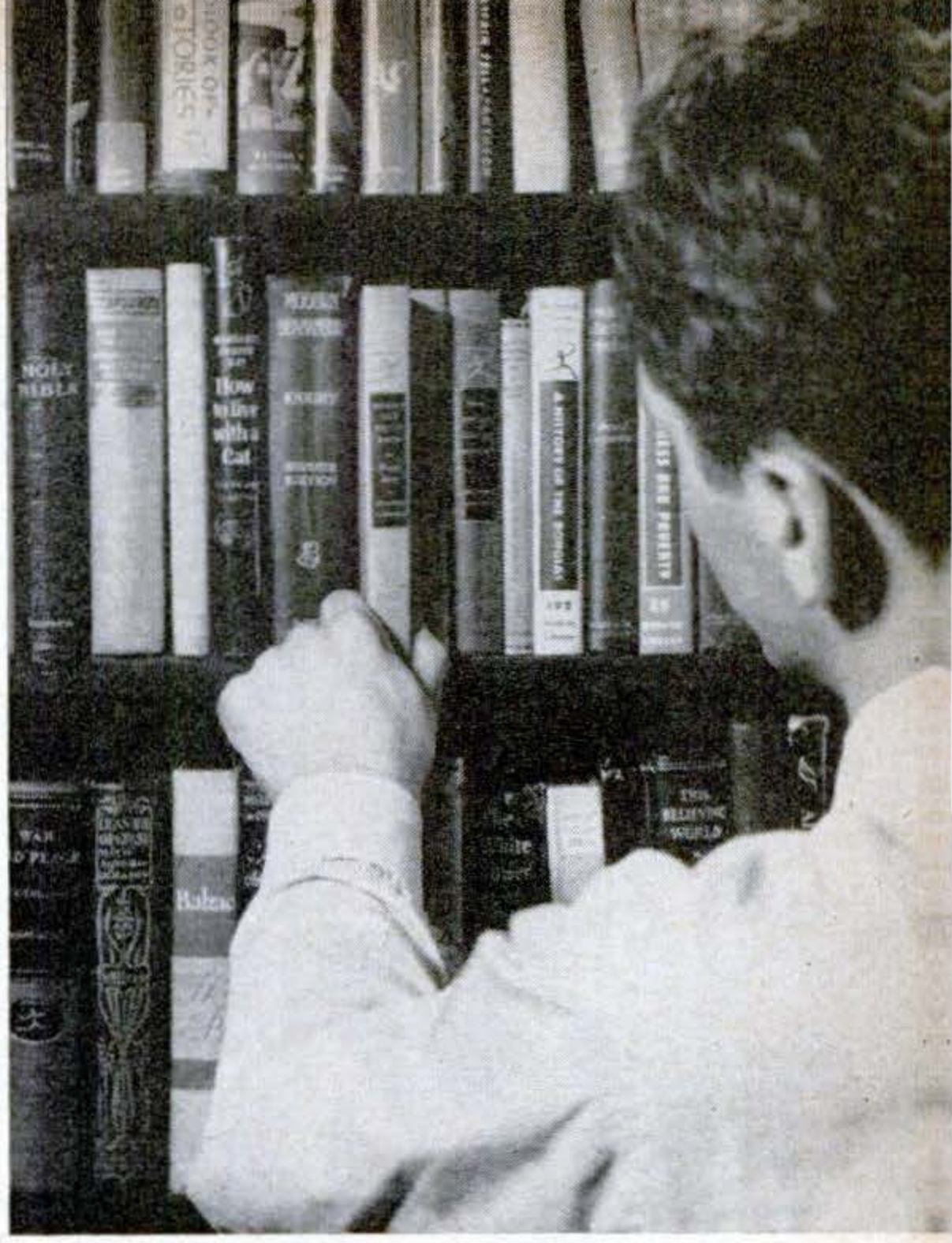
The books are subordinated in this photo, yet they still give atmosphere. Model was posed 36″ in front of them and shot made at f/4.5.



Emphasis is on the books here and the model is slightly out of focus, giving a feeling of separation between the two. Photo taken at f/8.

Focusing Your Interest

WHEN you stop down your camera to a small aperture, you lengthen the depth of field, that is, the distance within which objects are in focus. Likewise, if you shoot with the diaphragm wide open, or almost so, the depth of field is cut to narrow limits, and anything outside that range is out of focus. This lens characteristic is a valuable tool. These photos suggest how you can put it to use.—*Ken Swezey, Brooklyn, New York.*

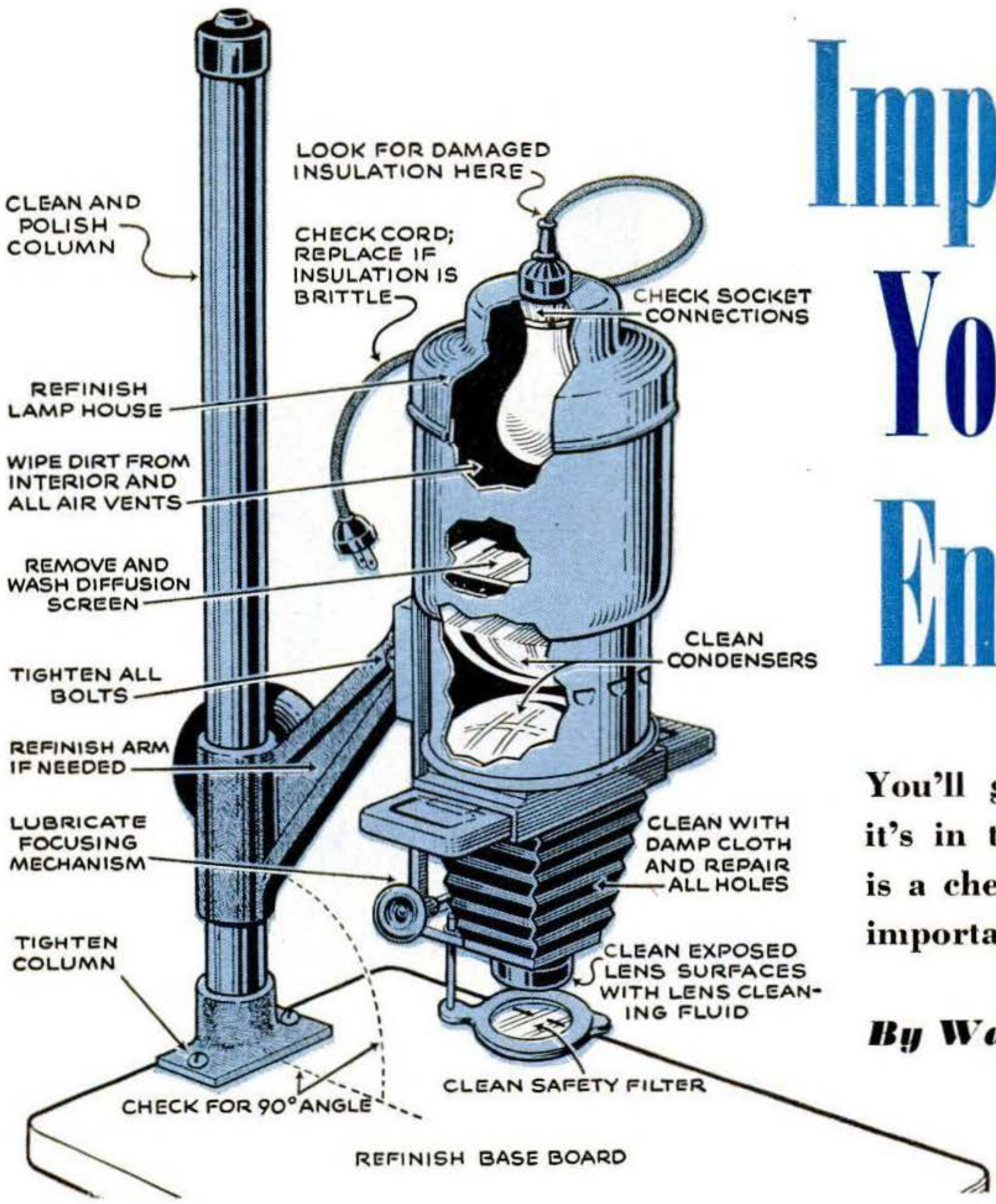
A background slightly out of focus centers your interest on the boy and his work. F/11 did the trick. Background objects give atmosphere.

A setting of f/2 was chosen here because the day was dark, and because a greater depth would have blended squirrel into background.

Improving Your Enlarger

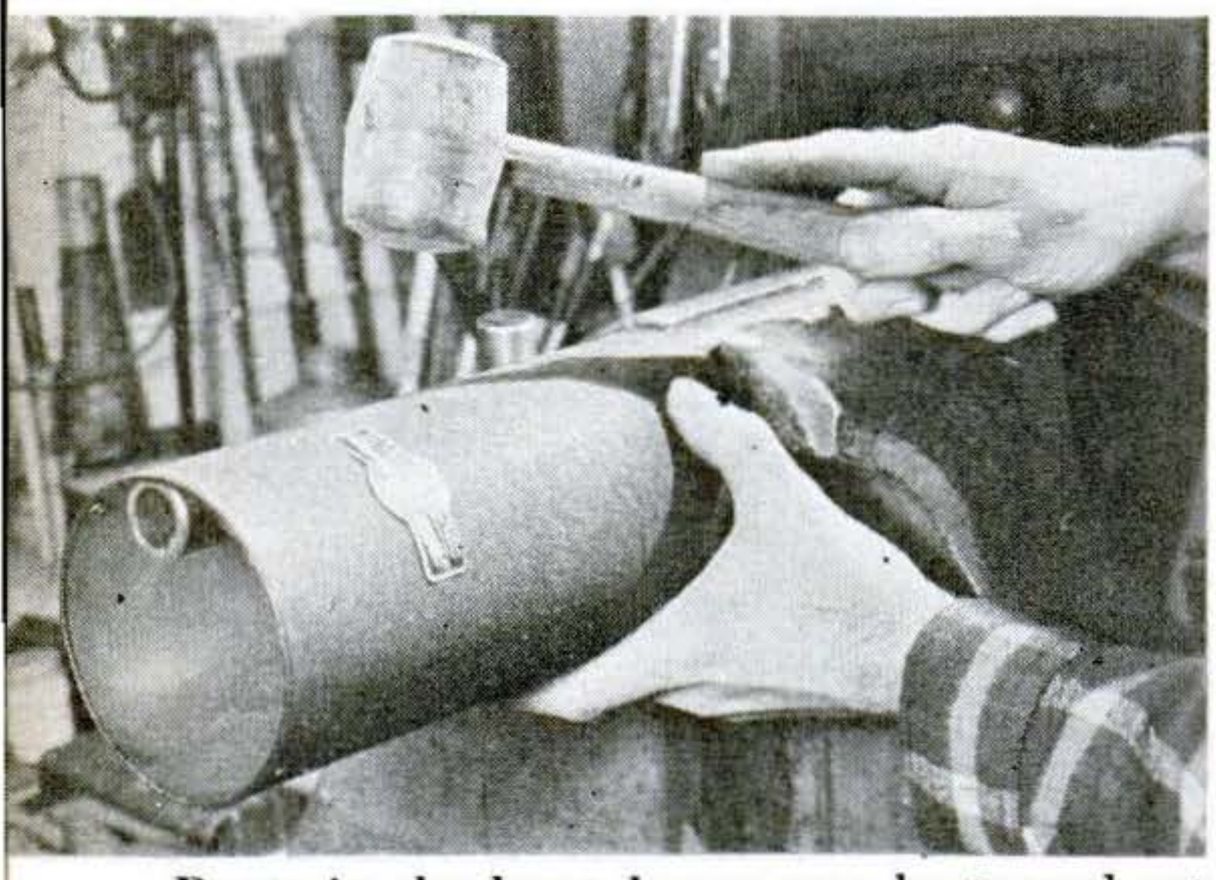
You'll get better prints if it's in top condition. Here is a check list of the more important points to cover.

By Walter E. Burton

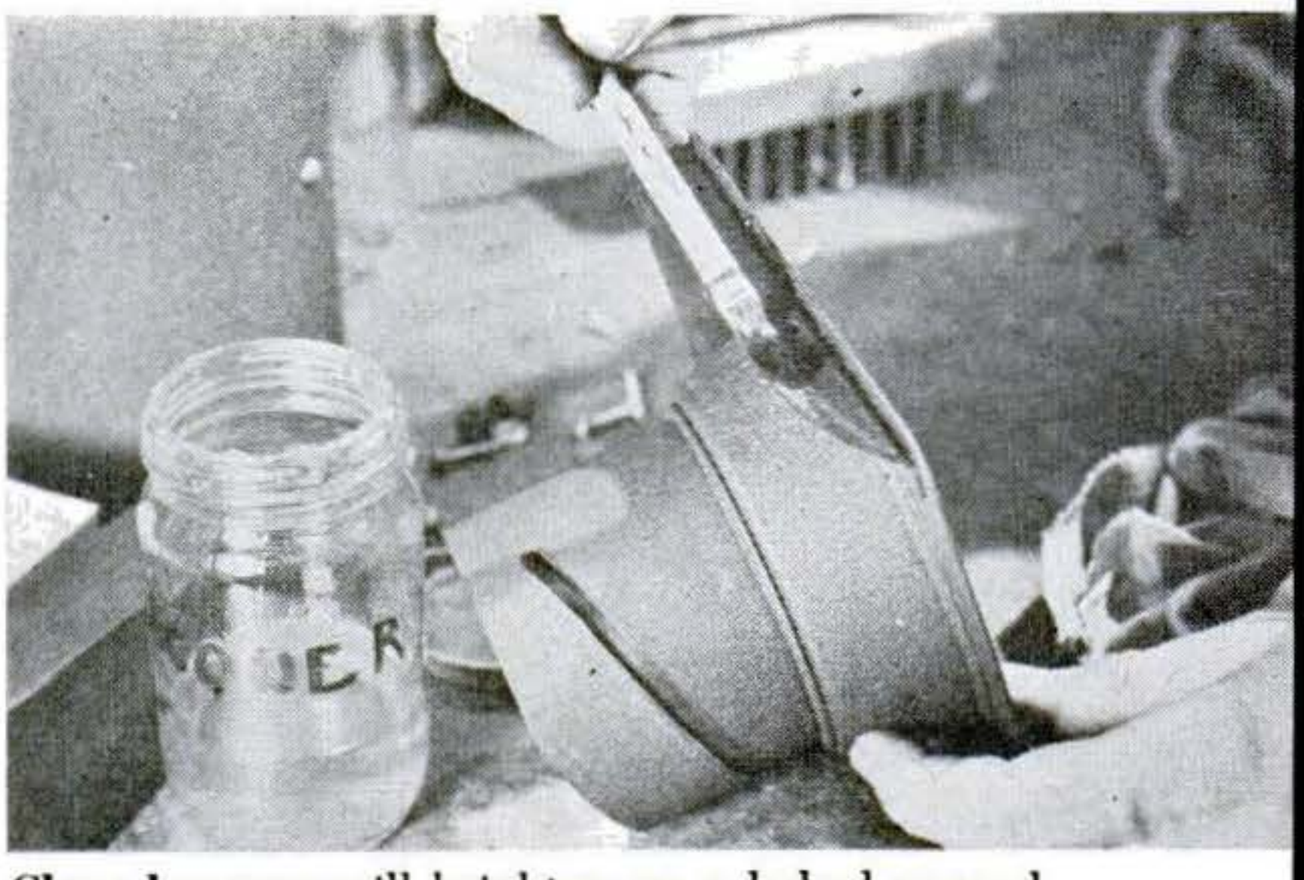


EVEN though you give your enlarger the best of care, the chances are it could stand a general overhaul from time to time. Some of the main points for this checkup are given in the drawing and photos.

As a starter, it'll probably be a good idea to remove all parts that appear to need attention—straightening, repainting, or cleaning. Clean off all grease and dust, using a cloth and dry-cleaning fluid or plain soap



Dents in the lamp house may be tapped out with a mallet and a piece of pipe held in the vise.



Clear lacquer will brighten up a baked-enamel crinkle finish. Thin the lacquer considerably.

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and water. Be careful not to apply water, however, to any part that might warp. An infrared lamp is handy for drying.

If some parts are rusty, wipe off all you can with a cloth. For stubborn cases, use No. 80 grit abrasive cloth, an old knife blade, or a wire brush. Then refinish or apply a light oil to the affected part.

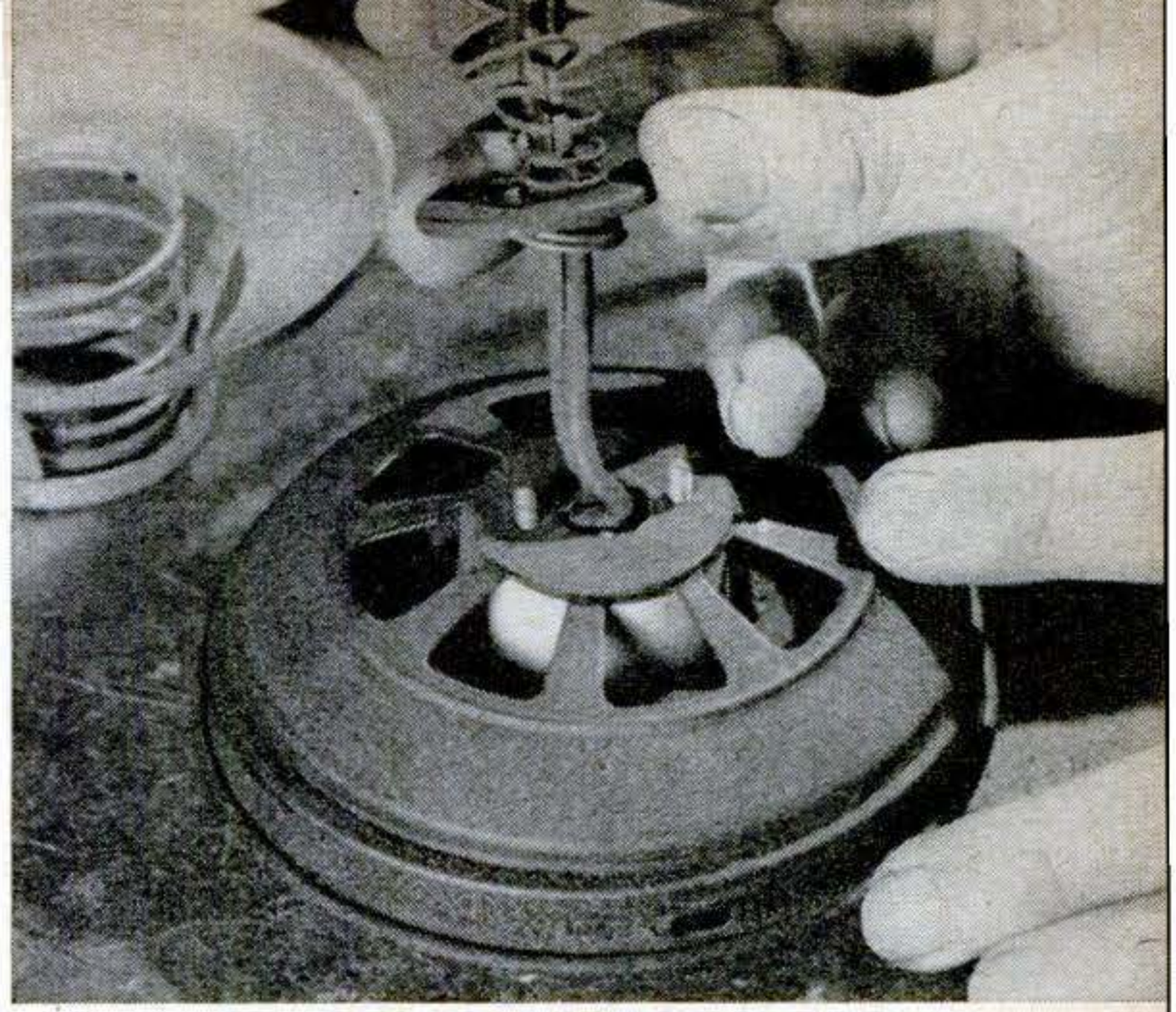
Areas that originally were enameled black can be cleaned and given a coat of black brushing lacquer or model-airplane dope. Interior surfaces of lens tubes, areas around the negative carrier, or other spots where light reflections are not wanted should be treated with dull-black lacquer.

The inside of the lamp house may need refinishing to increase its light-reflecting ability. If it's polished aluminum, you probably need only repolish it with very fine steel wool or a fine-grit abrasive paper. For other metal, such as chromium, a good nonscratching silver polish may do the job. When polishing is not the answer, try a coat of white casein paint.

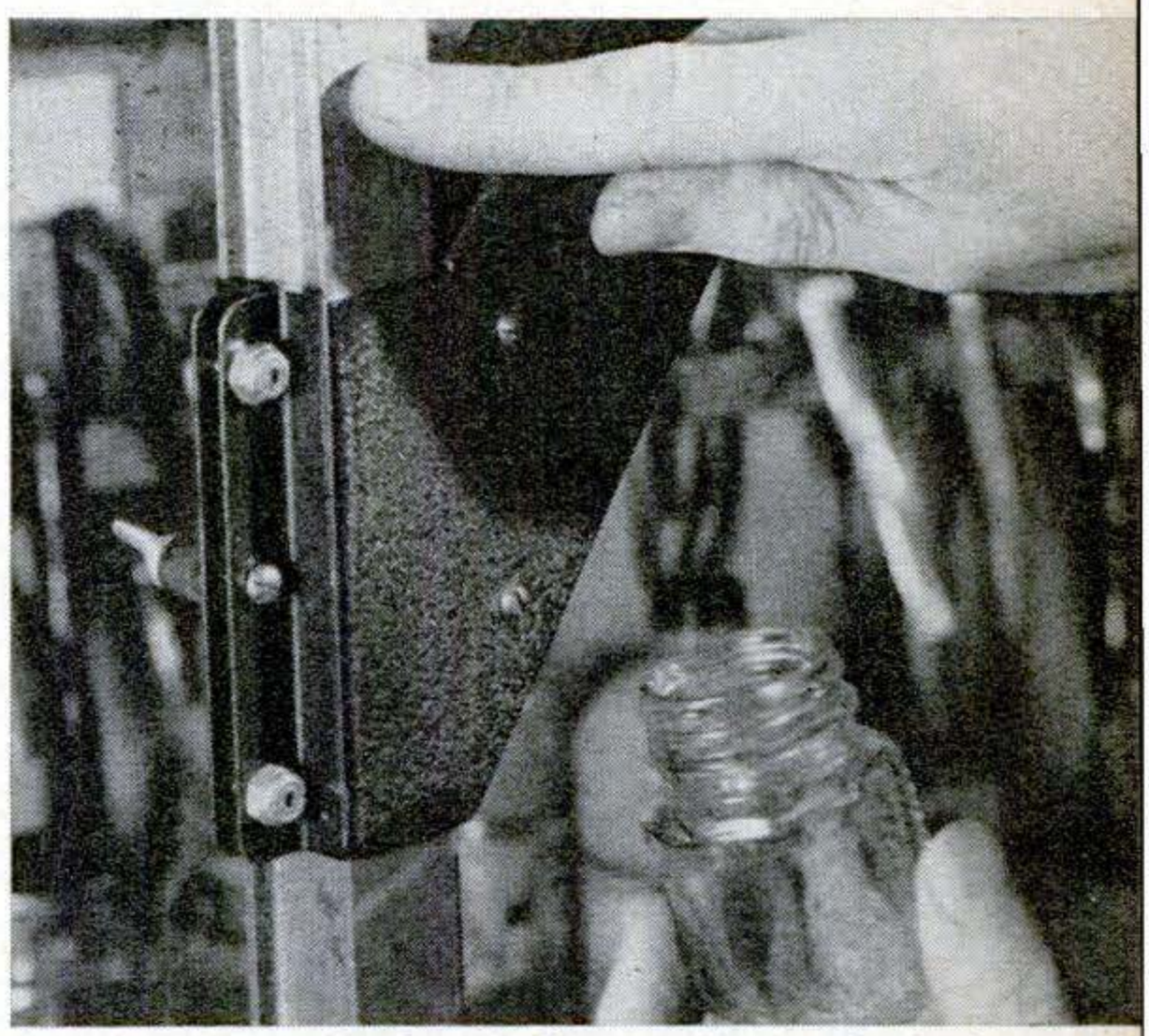
Unless your enlarger is an exception, its optical parts will require cleaning. Use a soft lens brush to whisk any gritty particles from the lens surfaces. Then apply a little lens cleaning fluid with lens tissue or a piece of well-worn handkerchief. Polish with dry tissue. Also clean the inner surfaces if the lens comes apart easily.

Clean the condenser and pressure-plate surfaces in the same way. Here you may use a mild soap and water. Rinse the surfaces thoroughly and dry with soft cloth.

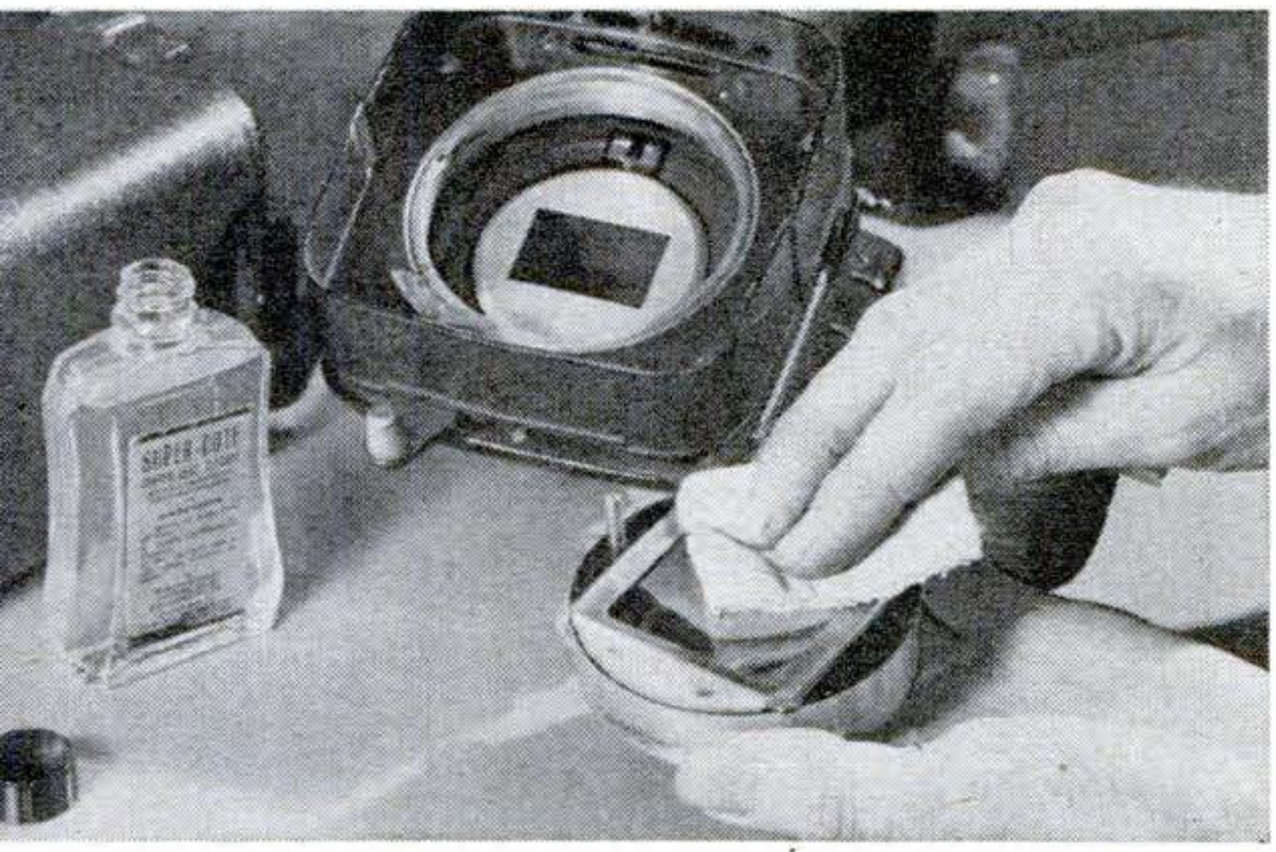
Check the alignment of the enlarger column with the baseboard. If the angle is not reasonably close to 90 deg., use shims to tilt the column in the right direction.



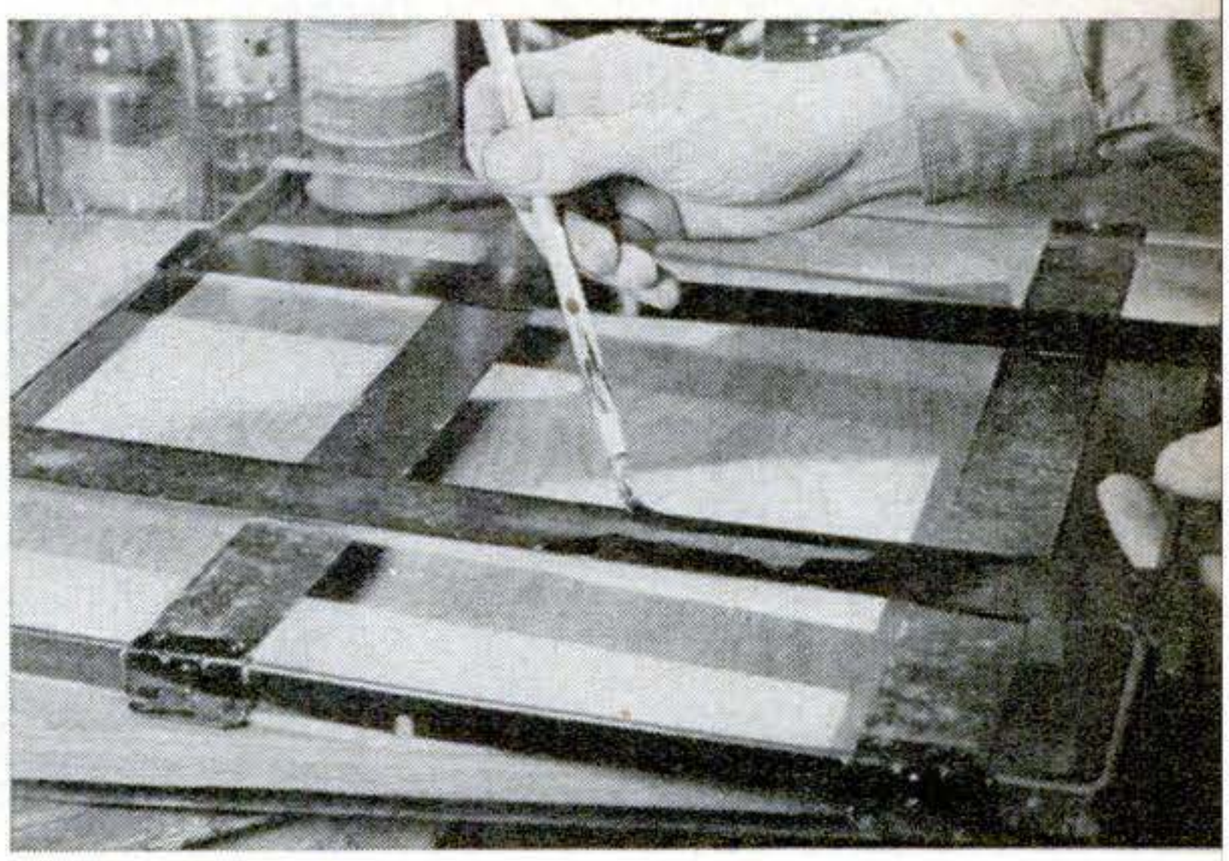
Inspect all electrical parts carefully. Replace any wiring that has worn or frayed insulation.



A light coating of petroleum jelly applied to the column will make the slide move smoothly.



Use a lens cleaner on glass surfaces. In such operations, keep a light touch. Don't scour.



Apply black lacquer to the masking strips on the easel. First, check for and remove rust.

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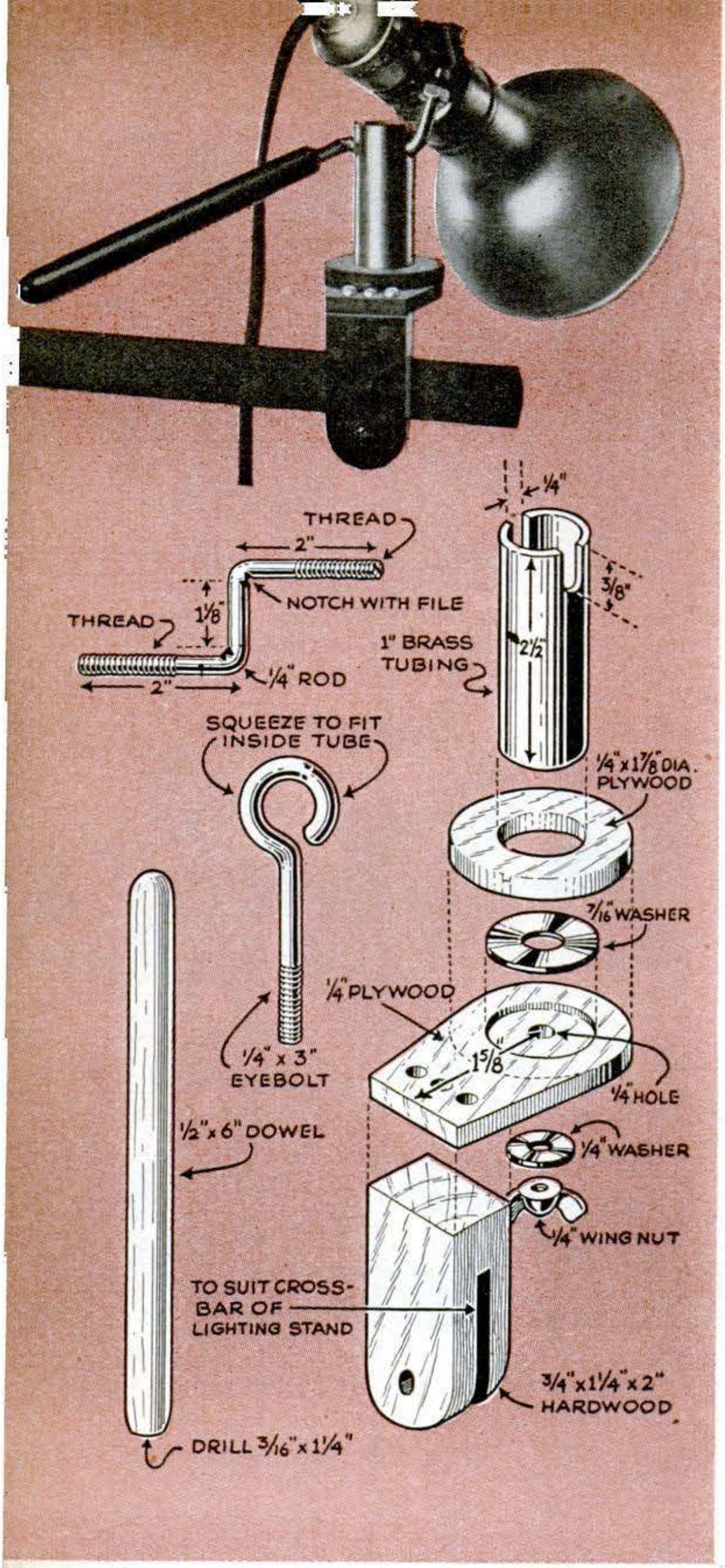
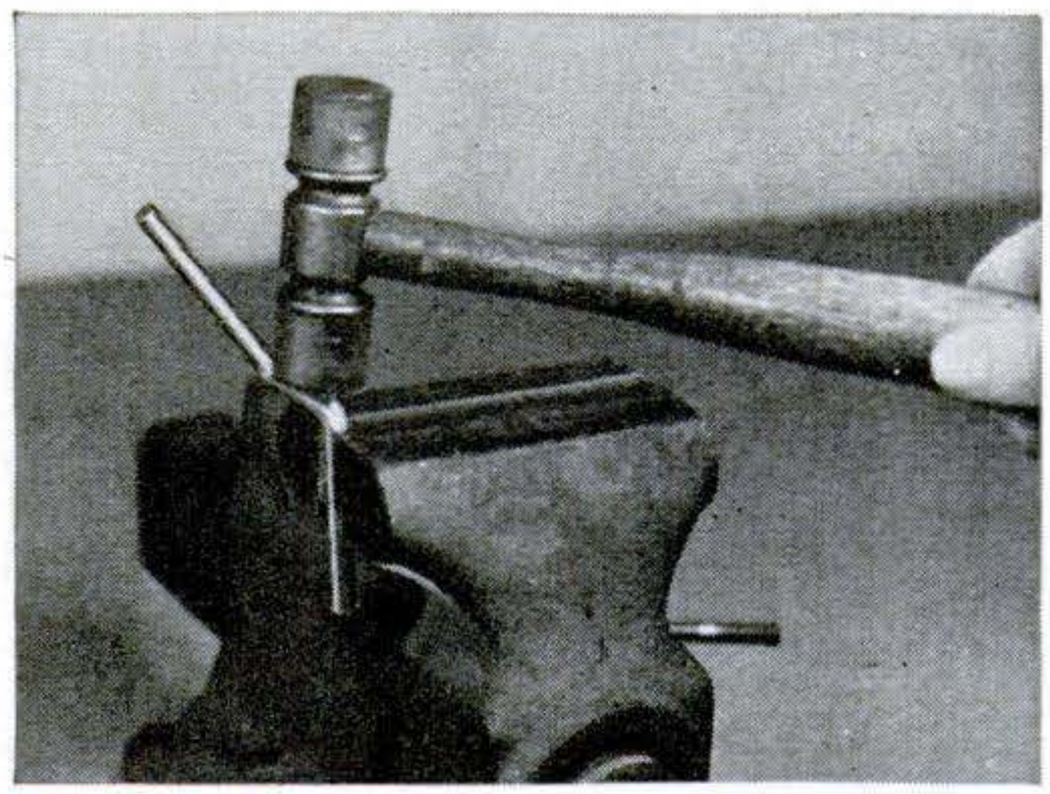
Flood Holder Pans and Tilts

A PAIR of these pan-tilt holders will enable you to aim your reflector photofloods exactly where you want. A bent bar provides tilting movement. The panning assembly consists of a 2½″ length of 1″ aluminum or brass tubing, a plywood washer, a metal washer, and a plywood base. Square the ends of the tubing and slot it as shown.

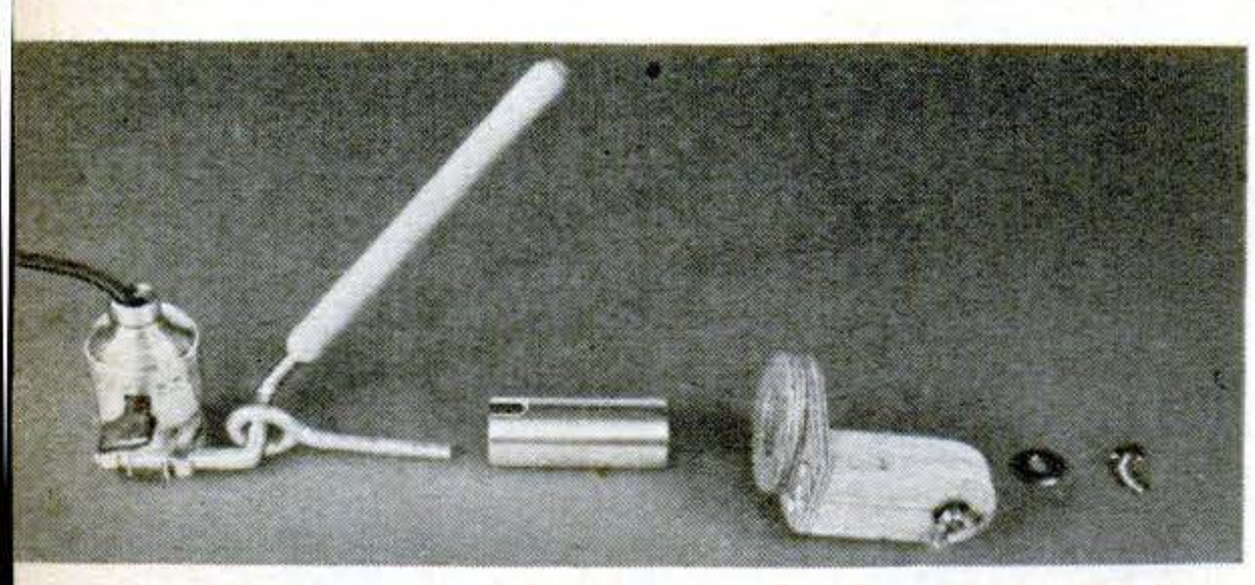
Squeeze the eye of the eyebolt in a vise until it just slips into the tubing. When you're ready for assembly, put a small compression spring between the washer and wing nut on the eyebolt. This will let you adjust the holder without loosening the nut.

Use hardwood for the bottom clamp. Its type and dimensions may be varied to suit the shape of the crossbar on your lighting stand.—*Don Pittwood, Moscow, Idaho.*

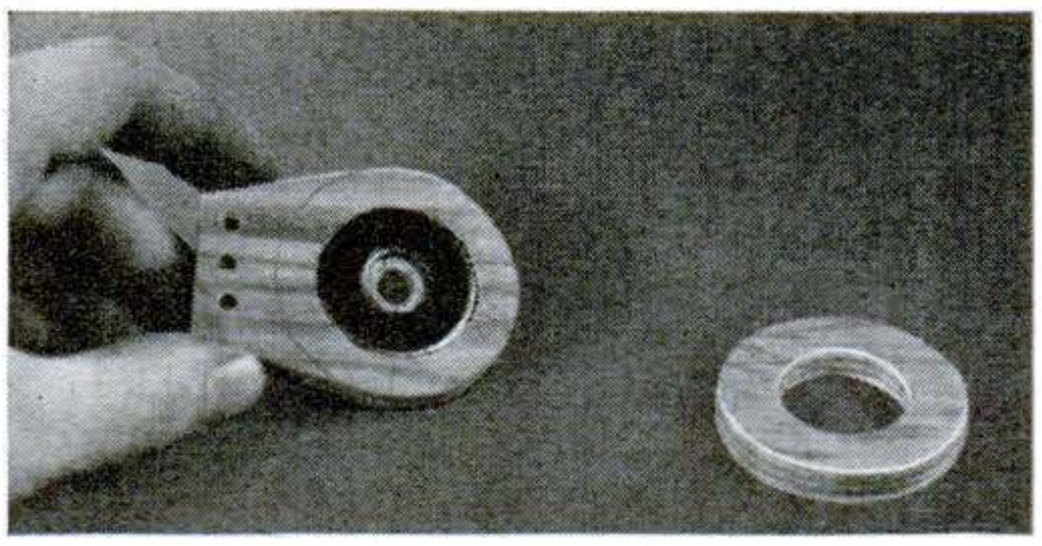




Bend the tilting bar from ¼″ rod, using a vise and soft hammer. File a notch inside each bend to make it sharper. Cut threads on both ends.



All parts are seen in order here. A 1¼″ hose clamp placed between hex nuts on the upper end of the tilting bar holds the lamp socket.



A metal washer set flush into the part shown provides a bearing for the panning tube. Brad the plywood washer on top of this as a guide.

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Low-Cost Parts Test Radios

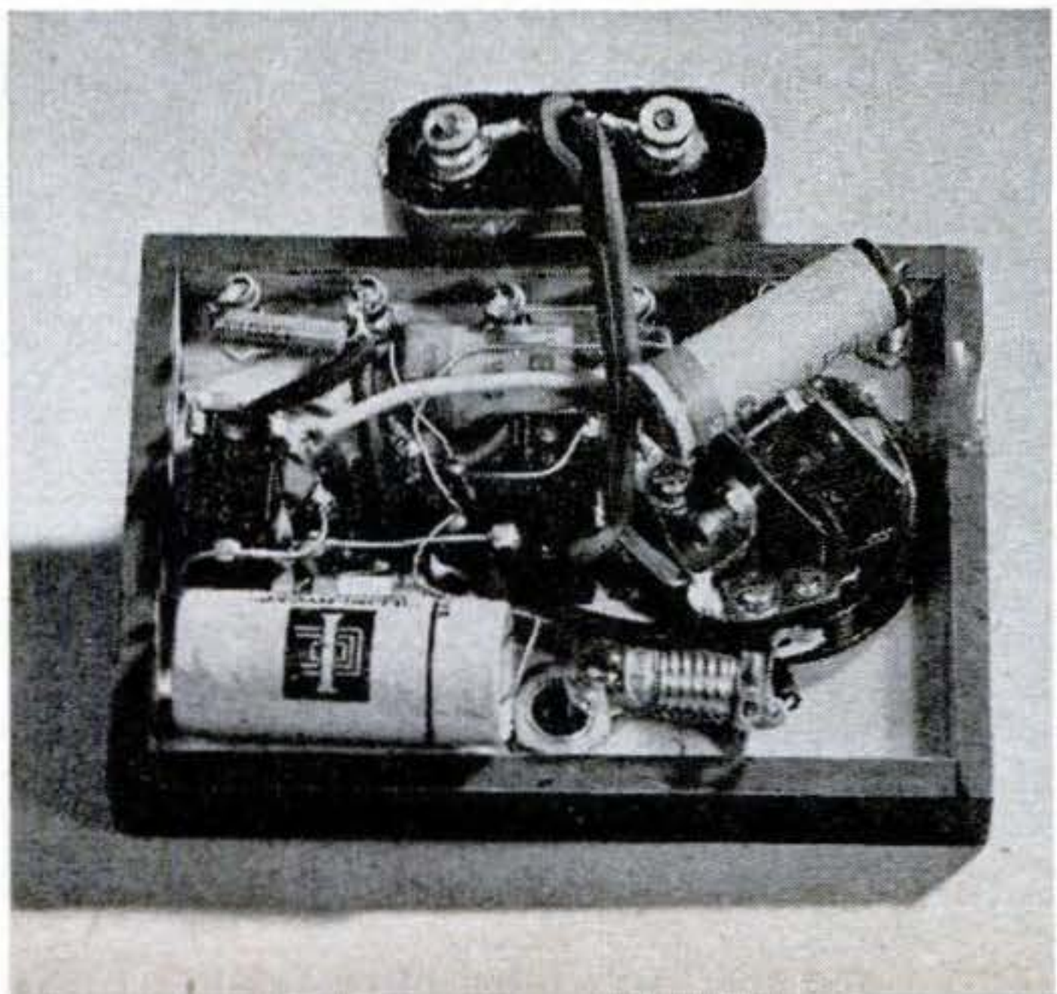
Most radio breakdowns are due to the failure of some one part. Here are some simple tests to help you find the trouble.

By Frank Tobin

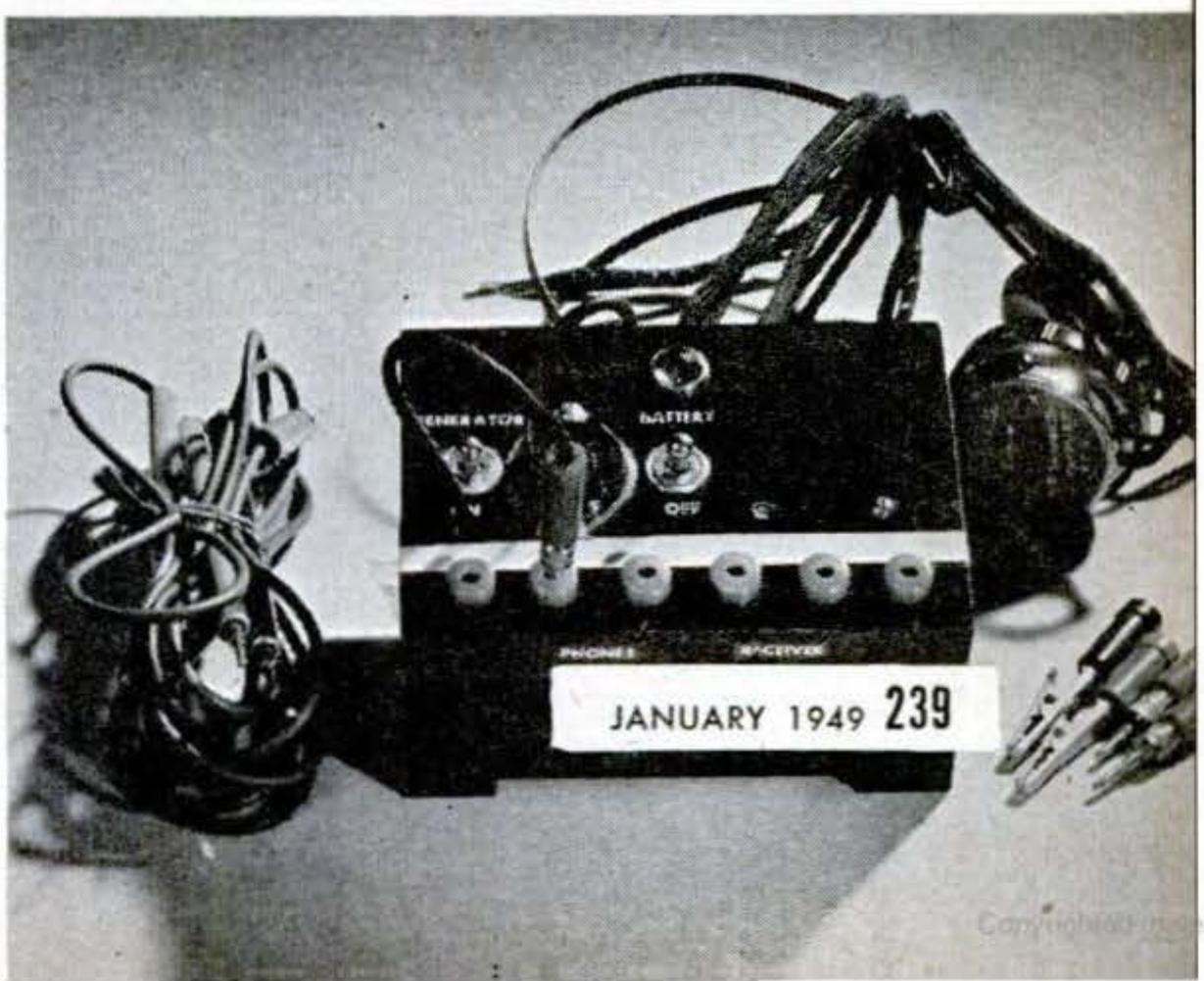
THERE'S no denying that radio servicing can be a complicated business. At its best it calls for a nice combination of theoretical knowledge and practical experience. But it also has its simple side, and here's why: when a radio that was playing well yesterday just stops operating or drops off in quality, the overwhelming probability is that some one thing has gone wrong. Moreover, some parts break down much more frequently than others. With a little basic knowledge and a lot of common sense you can usually find the guilty component pretty quickly.

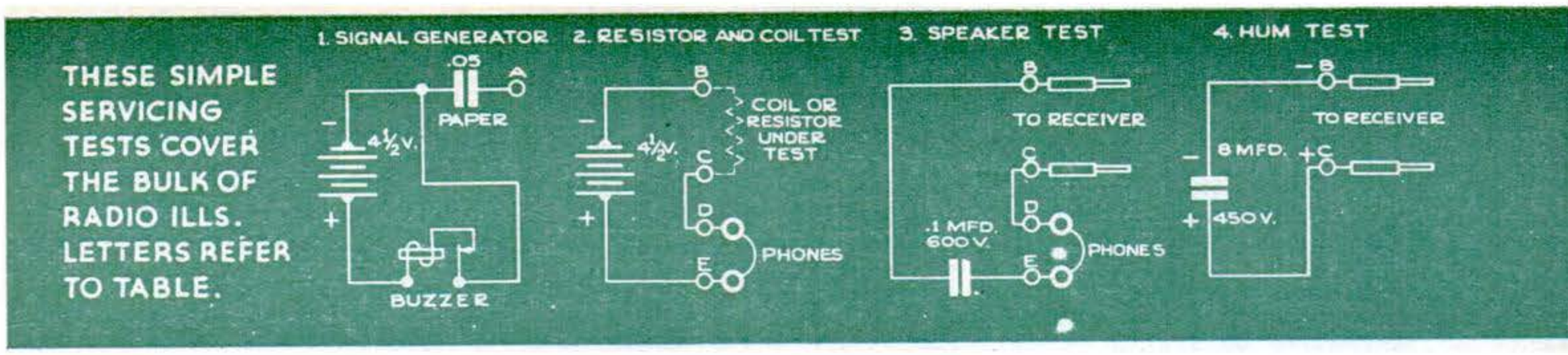
This doesn't mean that you're all set to go into the radio-repair business. It does mean that you're probably better than you may think at fixing your own or your friends' receivers. The miniature servicing "labora-

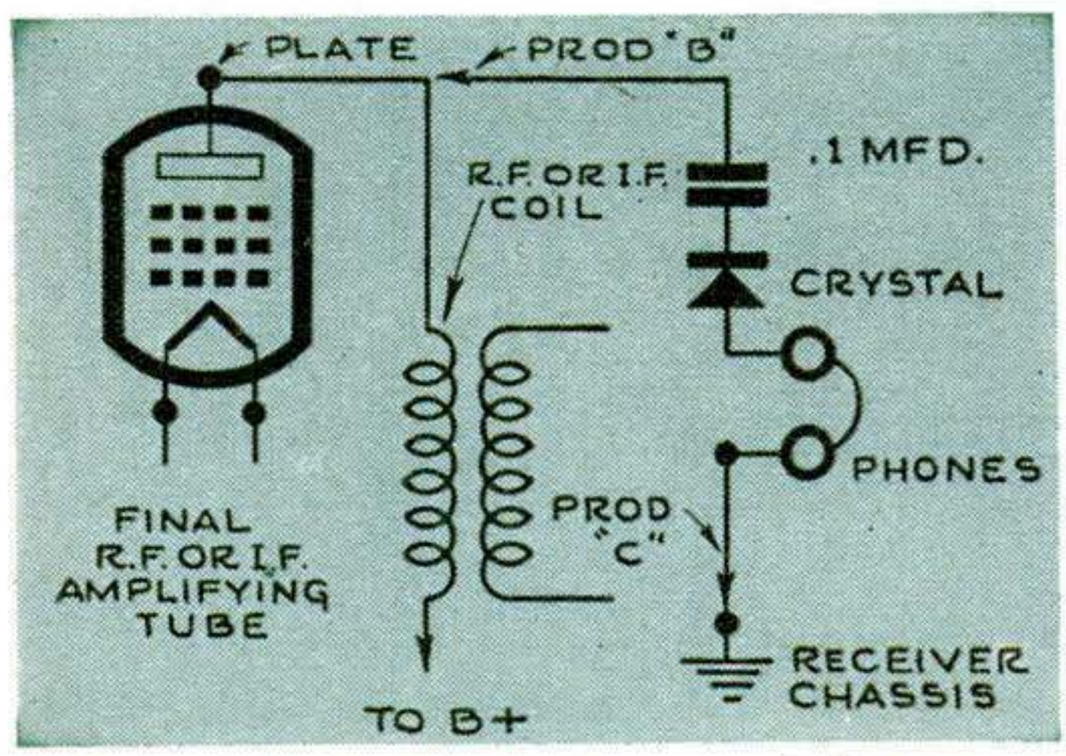
Nine separate servicing tests are possible with the parts crammed into this wooden box. The tests cover most common radio ailments.



Complete pocket laboratory. Extra equipment includes headphones and test prods. Auxiliary tips and clips for the prods are helpful.







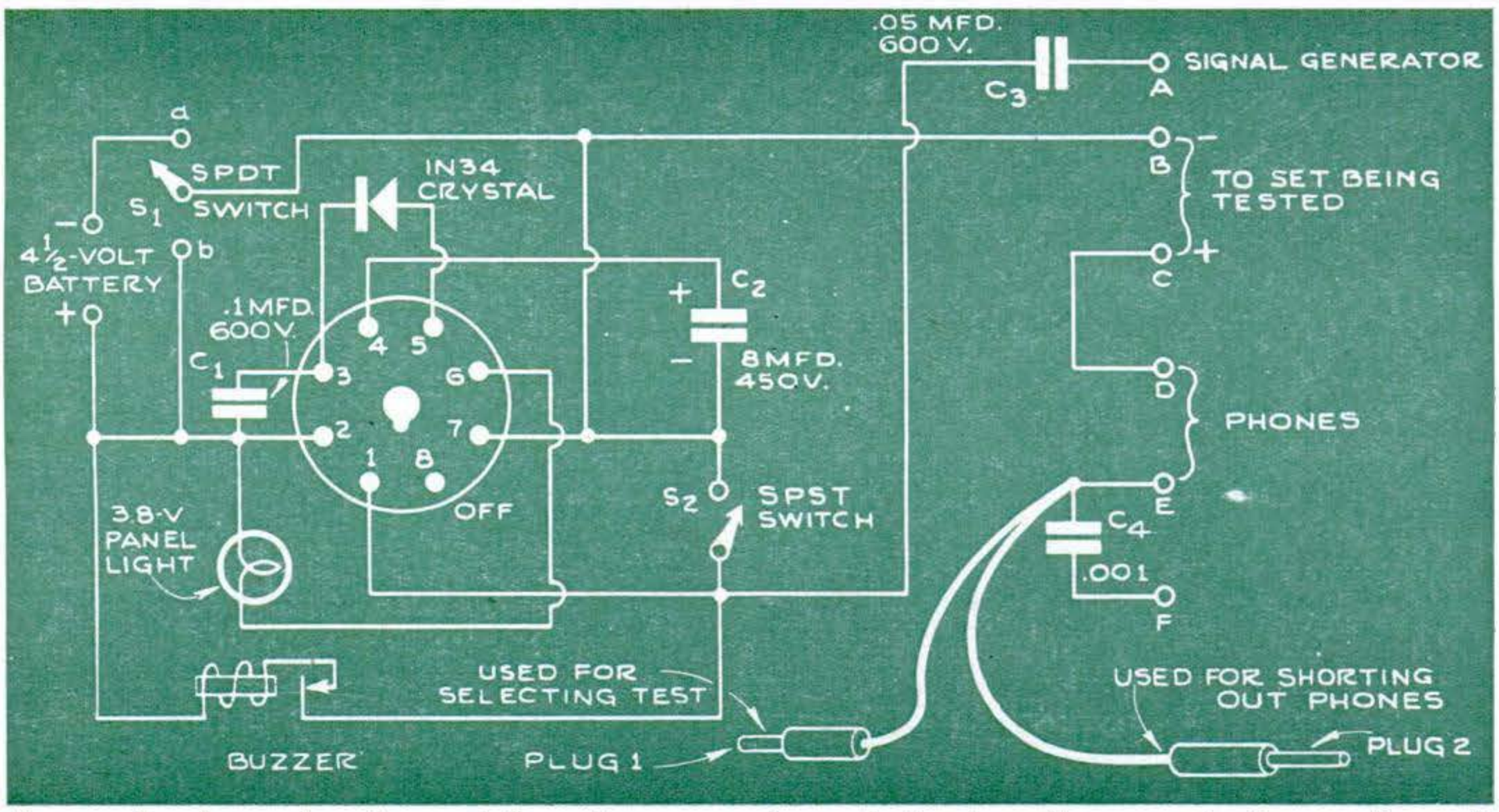
RF test No. 5 connects a crystal detector to the RF or IF plate. The circuit is shown above.

tory" shown in these photos cost only a few dollars to build. It is simply a collection of inexpensive parts that combine in one unit the various test setups shown in the diagrams across the top of these pages. Each test is complete in itself and requires only the parts indicated by the individual drawing.

For example, to inject an audible signal into a radio receiver, you need only a small buzzer, a battery, a .05-mfd. paper condenser, and a test prod. Put the prod on the grid pin of a tube—starting with the output stage and working back. If the signal is heard in the loudspeaker, you know that the stage being tested (and all those following it) are working. When it stops being heard, you have probably found the offending stage.

With the complete pocket laboratory you can carry this test one step further. The table describes the first part. To this setup add a pair of headphones by plugging them in at Jacks D and E, and another set of test prods at jacks C and F. With prod A on the grid of an audio tube (or the plate of the detector), prod C on the plate of the same tube (or the grid of the following one) and prod F grounded to chassis, you should be able to pick up the signal in the phones. Note, however, that it applies only to detector and audio tubes.

Common sense enters the picture in helping you select the order of the tests and de-



An octal tube socket is used for pin connections; jacks A to F are set in front of panel.

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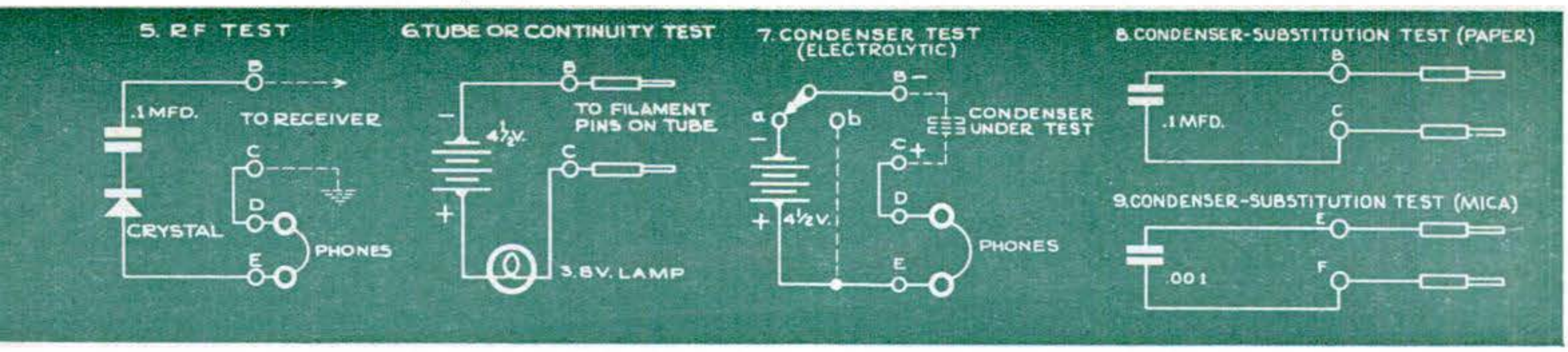

ciding which ones will be useful. If a set, for example, is not working at all and the tubes don't light up, the signal-generator test simply doesn't apply. In an AC-DC receiver, there's a good likelihood that these symptoms point to a burnt-out tube heater. Filaments are connected in series in sets of this kind, and when one goes the whole set stops working. Where a tube failure is suspected, check the filaments first. For this use test 2 or 6. Both are continuity tests, but the former will register (by a click in the headphones) even across a high resistance. The latter gives an indication (lighting up the pilot lamp) only if there is comparatively little resistance. If test 6 fails to indicate, always try test 2 before discarding a tube as burned out. The low-resistance test is also useful for straight continuity checks, while test 2 is invaluable for revealing open circuits across coils and resistors.

If the tubes light up but the set fails to play, there are a number of things to consider. An ordinary neon tester will tell you whether B-plus voltage is getting through from the rectifier. Use it carefully to avoid

HOW TO USE THE POCKET LABORATORY

TEST	PLUGS	JACKS	APPLICATION	S1	S2
1	Plugs not used	Test prod in Jack A	Signal-generator buzz is heard in speaker if tested stage is operating.	*a*	On
2	Plug 1 in Pin 2; Plug 2 not used	Phones in Jacks D and E; prods in B and C	Resistor and coil test. Click in phones indicates continuity through coil or resistor.	*a*	Off
3	Plug 1 in Pin 3; Plug 2 not used	Same as above	Speaker test used when no sound is heard and speaker, output tube, or transformer is suspected. (See text.)	*b*	Off
4	Plug 1 in Pin 4; Plug 2 in D	Test prods in Jacks B (—) and C (+)	Where hum or whistling is caused by defective filter condenser, placing prods across suspected unit diminishes hum.	*a* or *b*	Off
5	Plug 1 in Pin 5; Plug 2 not used	Phones in D and E; prods in B and C	Touch Prod B to plate of RF or IF tube, and C to chassis. If these stages work, phones give reception.	*b*	Off
6	Plug 1 in Pin 6; Plug 2 in D	Test prods in B and C	Continuity test; may also be used for checking burnt-out tube filaments.	*a*	Either
7	Plug 1 in Pin 2; Plug 2 not used	Phones in D and E; prods in B and C	Charge large electrolytics with S1 at *a*; throw to *b* and tap one prod against terminal. Phones should click as condenser discharges. (See text.)	*a* and *b*	Off
8	Plug 1 in Pin 3; Plug 2 in D	Test prods in B and C	Touch prods across terminals of suspected paper condenser. If condenser is faulty, operation should improve.	*b*	Off
9	Plugs not used	Test prods in E and F	Same as No. 8, but for mica and ceramic condensers.	*a* or *b*	Either

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The pocket laboratory quickly tracked down the fault in this receiver. Used for stage-by-stage checking, it's a valuable service tool.

shocks. Put one terminal on the chassis or ground and the other on a screen-grid or plate pin of a tube. If the neon lamp glows, the voltage is probably adequate.

But let us assume that you are getting the necessary voltage and none of the tubes is burned out. This could suggest that the receiver itself is functioning but that the speaker or output transformer isn't. Test 3 will tell you whether this is so. Touch one test prod to the plate of the output tube and the other to chassis and see if you can pick up a signal in the earphones. If you do, look for speaker trouble. It may be an open winding in the transformer or voice coil, in which case the defective unit will have to be replaced. The same test can be used at the plate of the detector tube. Should you get no signal in the phones, the trouble probably lies further back in the circuit. Use the signal-generator test, working back from the output until the faulty stage shows up.

Or you can start from the "front end" of the receiver with RF test No. 5. This test, in effect, constitutes an untuned crystal set. By adding it to the tuned RF portion of a set you can get headphone reception, provided the RF circuits are operating.

Hum in a receiver is frequently caused by a faulty electrolytic condenser in the filter circuit or in the cathode-bias of a tube. Test 4 puts an 8-mfd. electrolytic in parallel with the suspected condenser. If hum is reduced, the condenser in the set should be replaced. Observe polarity in making the test. Prod C goes to the positive side of the electrolytic and prod B goes to the negative side or chassis.

When you suspect a paper condenser of being shorted, make continuity test No. 6. If the pilot lamp glows, double-check by unsoldering one lead of the condenser and repeating the test on it alone. With one lead open, use test 8 to put a good condenser in the circuit.

Test 7 applies to the larger electrolytics used in filter circuits. The index of a good electrolytic is its ability to store a charge. With the set turned off put prods B and C across the condenser, observing polarity. Throw S1 to position *a* to put the battery in series with the condenser. Change S1 to position *b*, then lift either one of the prods for a fraction of a second. This is almost a rubbing or a tapping motion. As the stored charge leaks off, you should hear rapidly diminishing clicks in the headphones. With smaller electrolytics the 4½-volt battery won't store enough of a charge to click the phones.

There are some additional rule-of-thumb tests you can make when you want to find out the condition of a condenser. These are based on the observation that when you put a good condenser in parallel with a bad one, part of the trouble caused by the defective unit should clear up. A leaky or open condenser (as distinct from one that is shorted) may cause loss of volume, distortion, or other symptoms. Tests 4, 8, and 9 are substitution tests for electrolytic, paper, and mica condensers respectively. They put a condenser that is known to be good across one that is suspected. If the suspicion is correct, the test should produce a marked improvement in set performance. Replace the faulty unit.

Make all tests with caution. Be sure the power is off when it isn't actually needed for the check you are making.

Building the pocket laboratory consists simply of putting the components used in the individual tests into a single box. A wooden box measuring 1¾" by 3¼" by 4½" was used here. The dimensions aren't critical. Neither are the parts, except that they must be dependable and of good quality. A high-frequency buzzer, capable of operating on a 4½"-volt C battery is another requirement. The jeweled panel lamp was purchased as a complete assembly with socket and mounting bracket; the 1N34 crystal is a germanium diode.

Since connections must be interchangeable, all contacts should be uniform in size. Phone tips are convenient, since headphones come equipped with them and test prods may be so purchased or the original tips can be replaced. They also allow the use of on octal tube socket to permit selection of pin positions. END

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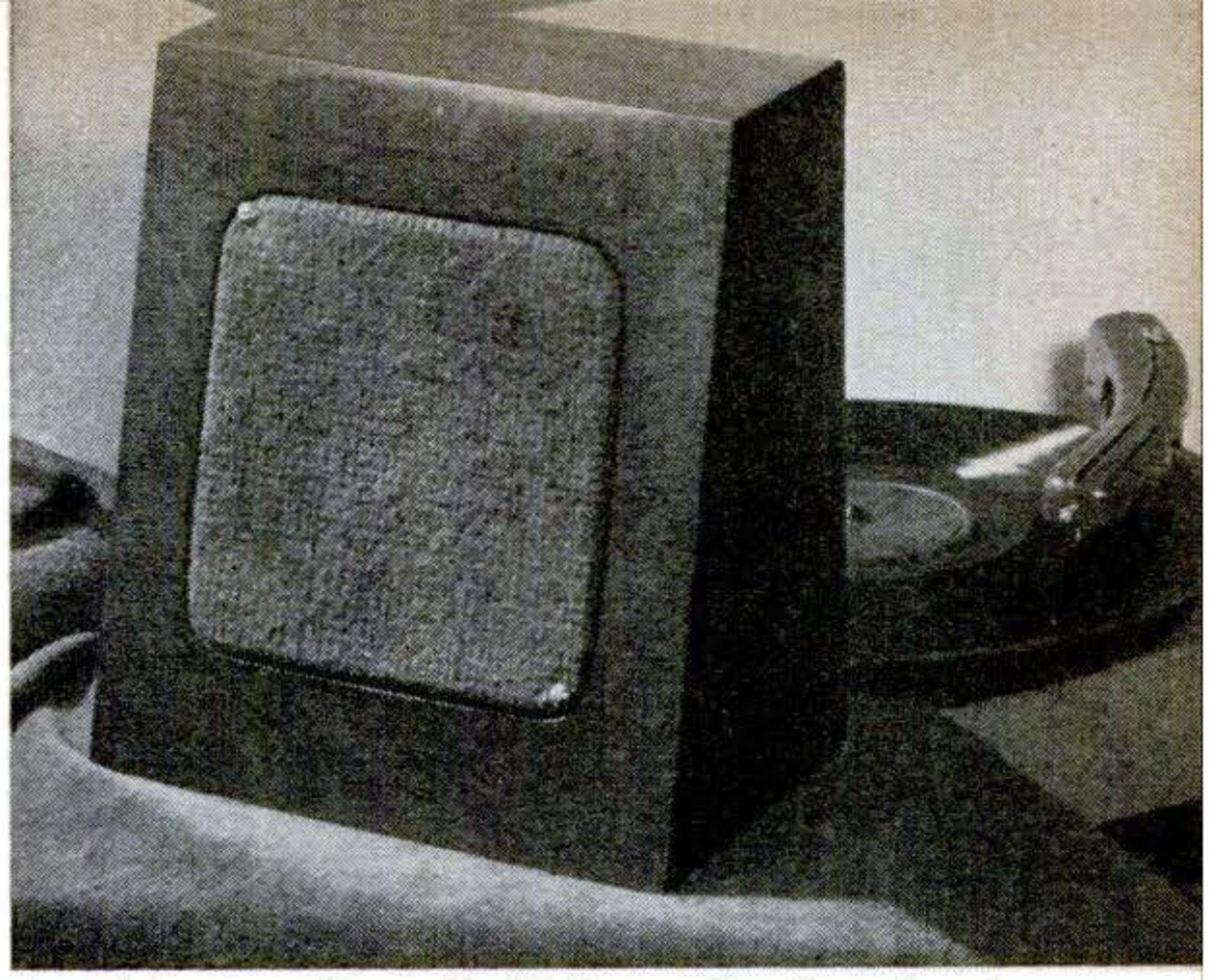
Amplifier Built on Speaker Frame



A cabinet made to hold just a loudspeaker is used here to house the entire amplifier unit.

IF YOU want real compactness in an audio amplifier, here's an interesting way of making the entire unit as small as a loudspeaker alone. The one-piece playing mechanism can be easily carried where it's wanted, and it can be stored or cabineted in minimum space.

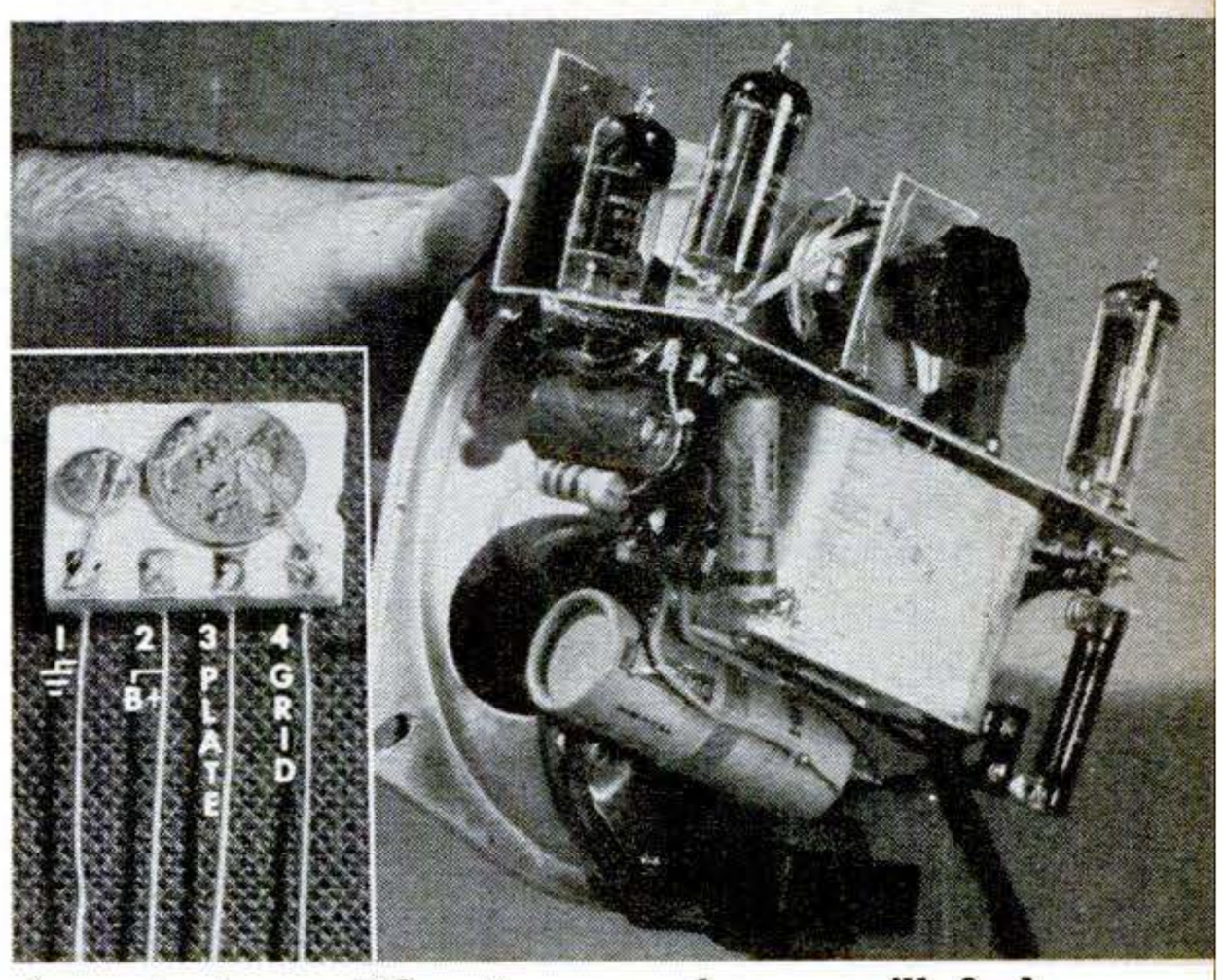
Primarily designed for use with a phono pickup, the amplifier can also be connected to a radio tuner or even a one-tube receiver to provide loudspeaker reception. It is not particularly recommended for use with a microphone.

A 6″ permanent-magnet speaker was chosen for the reproducer, and the chassis dimensions are calculated accordingly. A sheet of aluminum is cut to the size and shape shown, the front legs are bent up and bolted directly to the speaker frame. A bracket for the volume control is cut separately and screwed to the chassis.

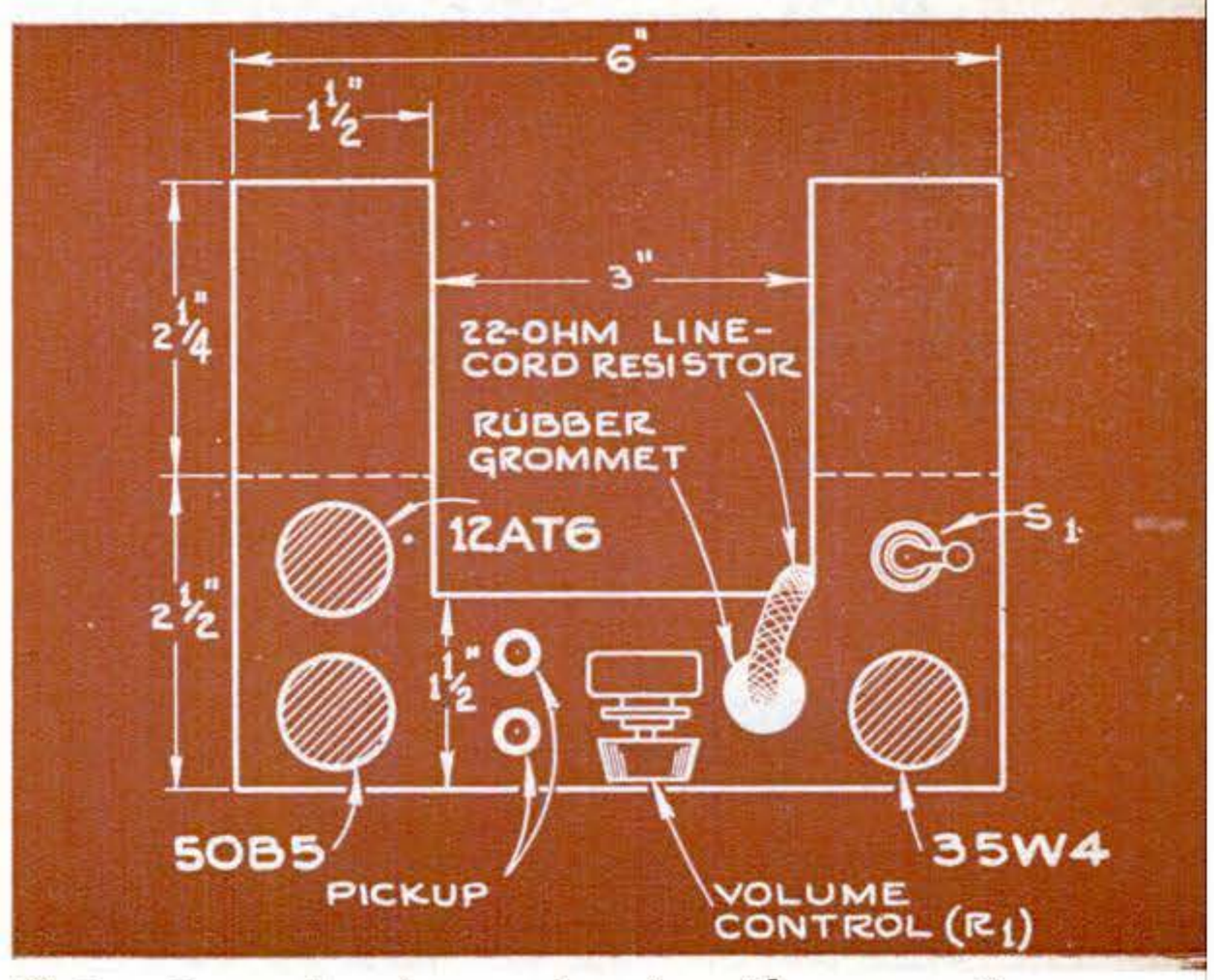
One of the space-saving devices used in this amplifier is a coupling circuit printed on a small ceramic plate. This Couplate®, manufactured by Centralab, consists of two resistors and two condensers. At present it is used chiefly by manufacturers and may therefore not be easy to pick up. If you can get one, it's all to the good; if not, simply substitute the values designated in the parts list.

Three ⅝″ holes are punched in the chassis to accommodate the 7-pin miniature tube sockets. Additional, smaller holes are needed for the two input jacks for the pickup or tuner, for S1, the SPST on-off switch, and for the rubber grommet that protects the line-cord resistor.

The line cord is of the universal type that gives a selection of resistance values. From the instruction sheet packed with the cord



As a test amplifier in your shop, you'll find many uses for this compact outfit. Inset shows a printed ceramic coupling unit. The numbers correspond to those in diagram on next page.



Cut out an aluminum chassis with saw or tin snips. These dimensions are for a 6″ speaker.

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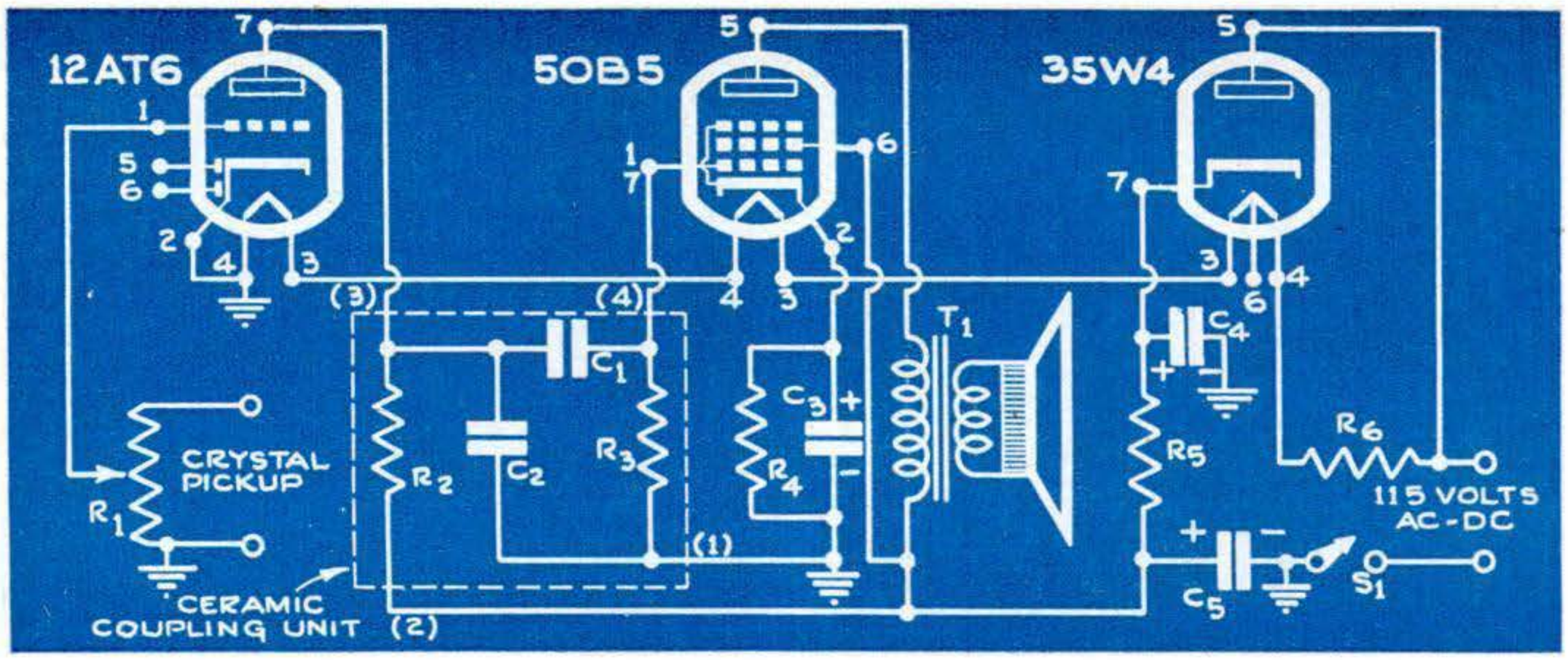


LIST OF PARTS

R1: ½-meg. volume control.
*R2: 250,000-ohm, ¼-watt carbon.
*R3: 500,000-ohm, ¼-watt carbon.
R4: 150-ohm, 1-watt carbon.
R5: 1,000-ohm, 5-watt wire-wound.
R6: Universal line-cord resistor. (Use 22-ohm tap.)
*C1: .01-mfd., 200-volt paper.
*C2: .00025 mica.
C3: 10-mfd., 25-volt electrolytic.
C4, C5: 24-24 mfd., 150-volt dual electrolytic.
S1: SPST toggle.
T1: Midget output transformer for 50B5 or equivalent, or universal.
6" PM speaker, tubes, 7-pin miniature sockets (3), banana plugs and jacks (2), misc. hardware.
*These individual parts may be substituted for the printed ceramic coupling unit used in the original.

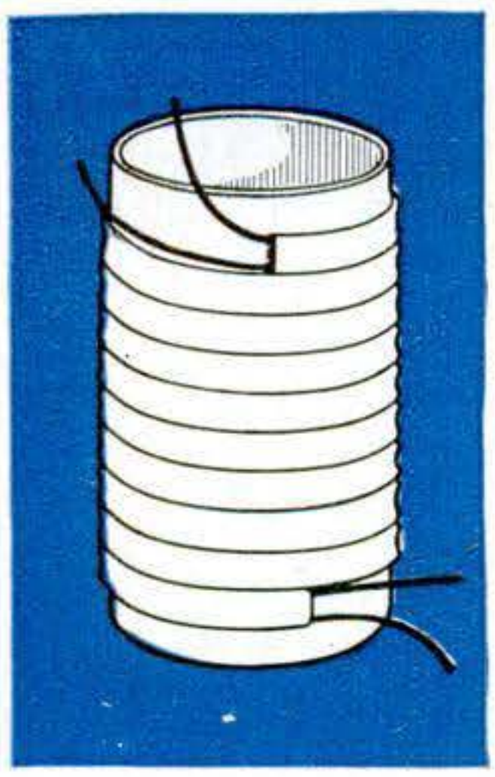
you can select the proper leads and cut off the others. The value needed here is about 22 ohms.

If you plan to mount the speaker so that the controls can be reached only from the back, transpose S1 and the 35W4.

Except for the banana jacks for the pick-up, most of the connections can be made either before or after the chassis is bolted to the speaker. However, the jacks must go on first. It's a good plan, moreover, to add as many parts as possible before attaching the chassis, since this will lessen the chances of solder, wire strands, or dirt falling into the speaker. Use shielded wire for the jacks and to connect the center arm of R1 to the grid of the 12AT6, and ground the outer braid to the chassis. Note that the electrolytic condenser (C4,C5) is mounted directly to the speaker frame rather than to the chassis; the same is true of the output transformer.

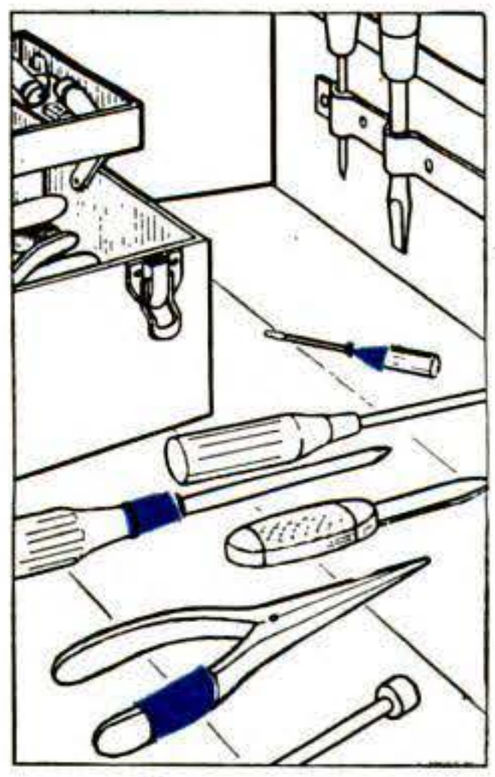
Because of the close connection of the chassis and speaker, all metal parts will be "hot," so don't let any part of it come in contact with an external ground.—*William Norton, Manhattan, N. Y.*

Coils Wound with Twin Lead



ONE of the simplest ways of making your own low-loss inductances or transformers with interwound primary and secondary is with twin-lead antenna ribbon. Coiled around a cardboard or composition tube, the primary is automatically interwound with the secondary. You can get equal spacing with 75-ohm ribbon; larger sizes will give uniform but unequal turns. Ends can be held fast with coil dope.—*Arthur Trauffer, Council Bluffs, Iowa.*

Paint Dabs Identify Kit Tools



HAVING had considerable difficulty in separating my service-call tools from those that stay in the shop, I adopted this sure-fire way of telling them apart. With a band of bright paint on each of the kit tools, I can now unpack them for a bench job and be sure of getting all the right ones put back in a hurry. It also identifies those I sometimes forget on a job. Customers recognize the markings and return my tools promptly.—*P. R. Wilson, Brooklin, Ont.*

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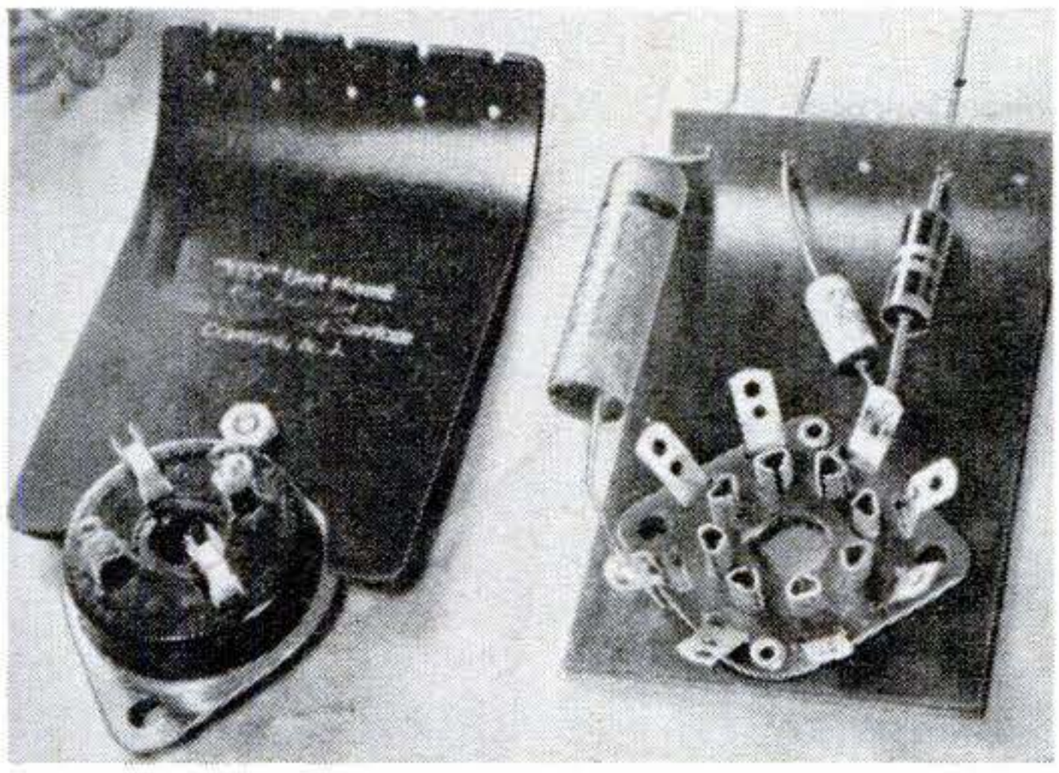
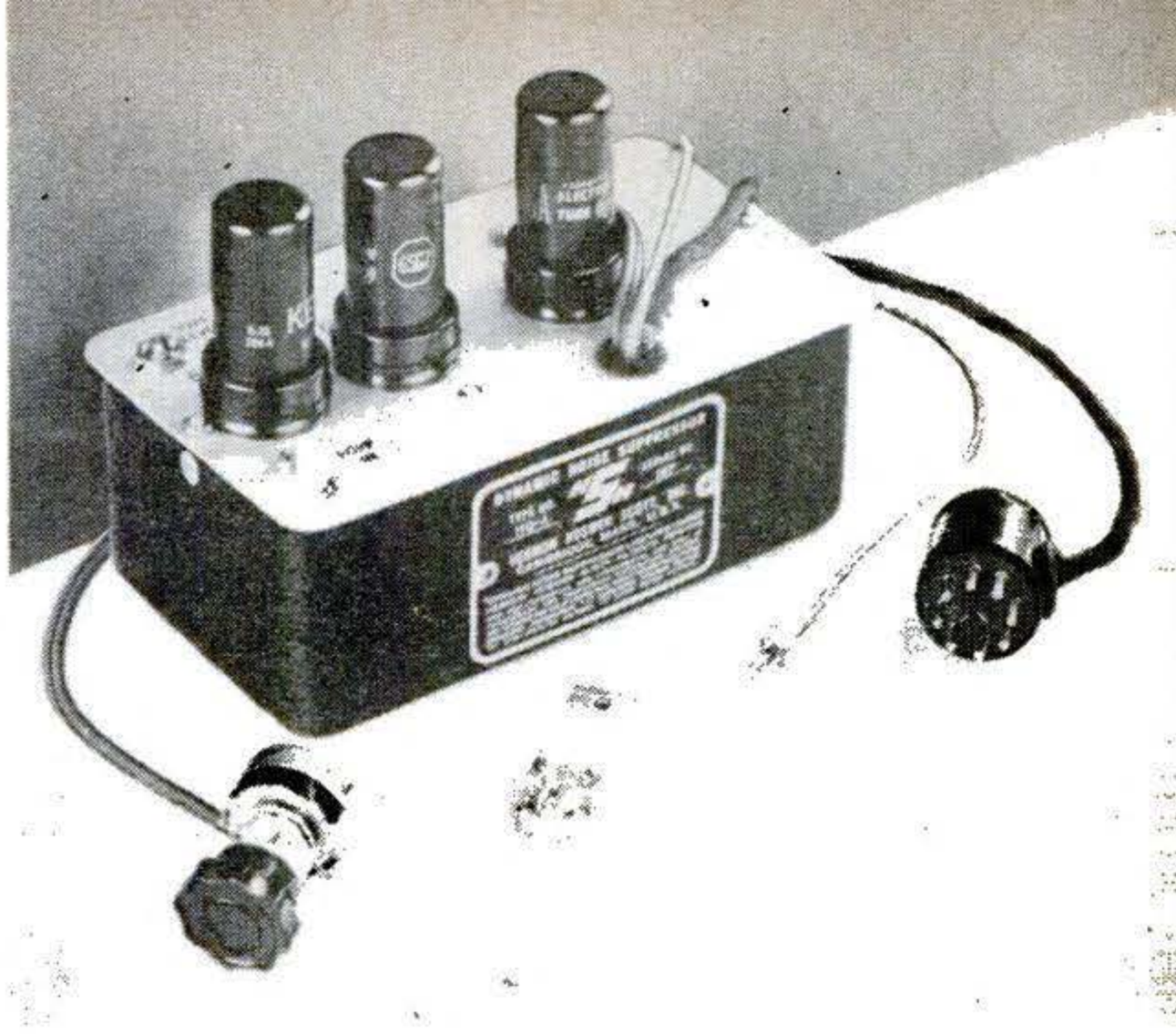
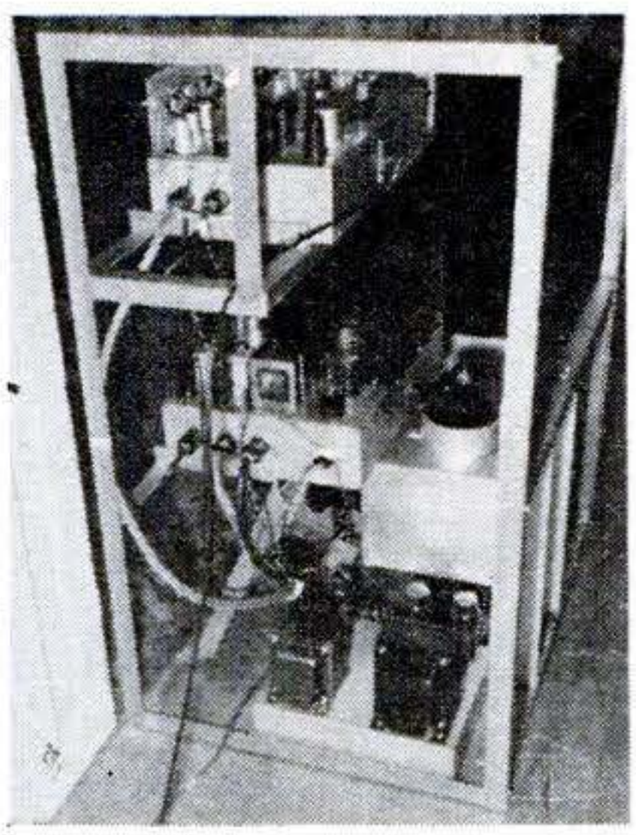
NEWS IN ELECTRONICS



Socket Plate Anchors Parts. Some of the difficulty that radio builders experience in anchoring the small parts that are soldered to tube-socket lugs is eliminated by the combination socket and mounting strip pictured above. It's a product of Yates Engineering Services, Cranford, N. J., and is available with or without the socket (for 25 and 10 cents respectively). Larger multiple units are also made.

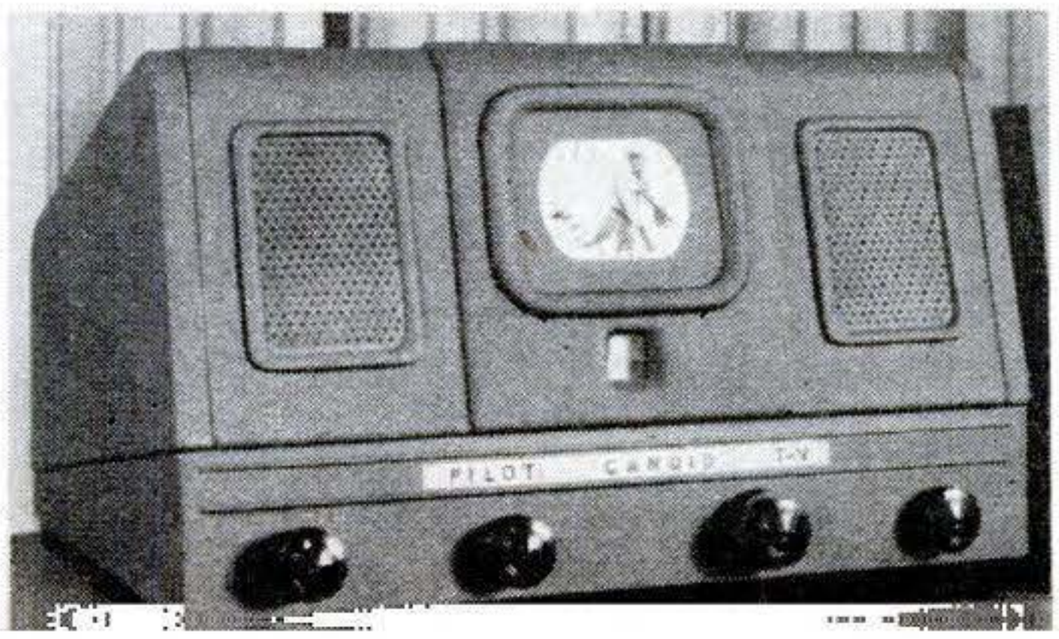


Suppressor Blocks Disk Noise. A smaller version of the Dynamic Noise Suppressor ™ (PS, June '47, p. 209) has been put out by Hermon Hosmer Scott, Inc., Cambridge, Mass. Unlike the larger original model, this comparatively low-cost unit (about $83) is suitable for most existing record players. It uses "gate" circuits that cut background noise with minimum loss of quality and high-frequency tones.



Custom-Built TV. A large-screen television receiver designed for installation in the wall of a house is marketed by Television Assembly Co., Brooklyn, N. Y. Subchassis of various kinds can be supplied so that the finished set is tailored to the buyer's requirements. The largest model, shown here, retails for about $1,300 installed. It uses a 5" tube to project a 20" by 26" picture.

Television Set Weighs 15 lb. A lightweight, small-screen TV receiver selling for about $100 is being manufactured by Pilot Radio Corp., Long Island City, N. Y. The set can easily be moved about the house, and comes with a doublet wire for an inside antenna. It has a 3" picture tube.



Plastic Pane Can Be Drilled. Bringing antenna lead-in wires through a window to a transmitter or receiver sometimes involves drilling the sash or glass. Recognizing this problem, American Phenolic Corporation, Chicago, sells clear polystyrene sheets precut to window-pane sizes.

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Heated Driveways Lick Ice and Snow

They're efficient snow removers, but for most people the installation cost keeps them in the luxury class.

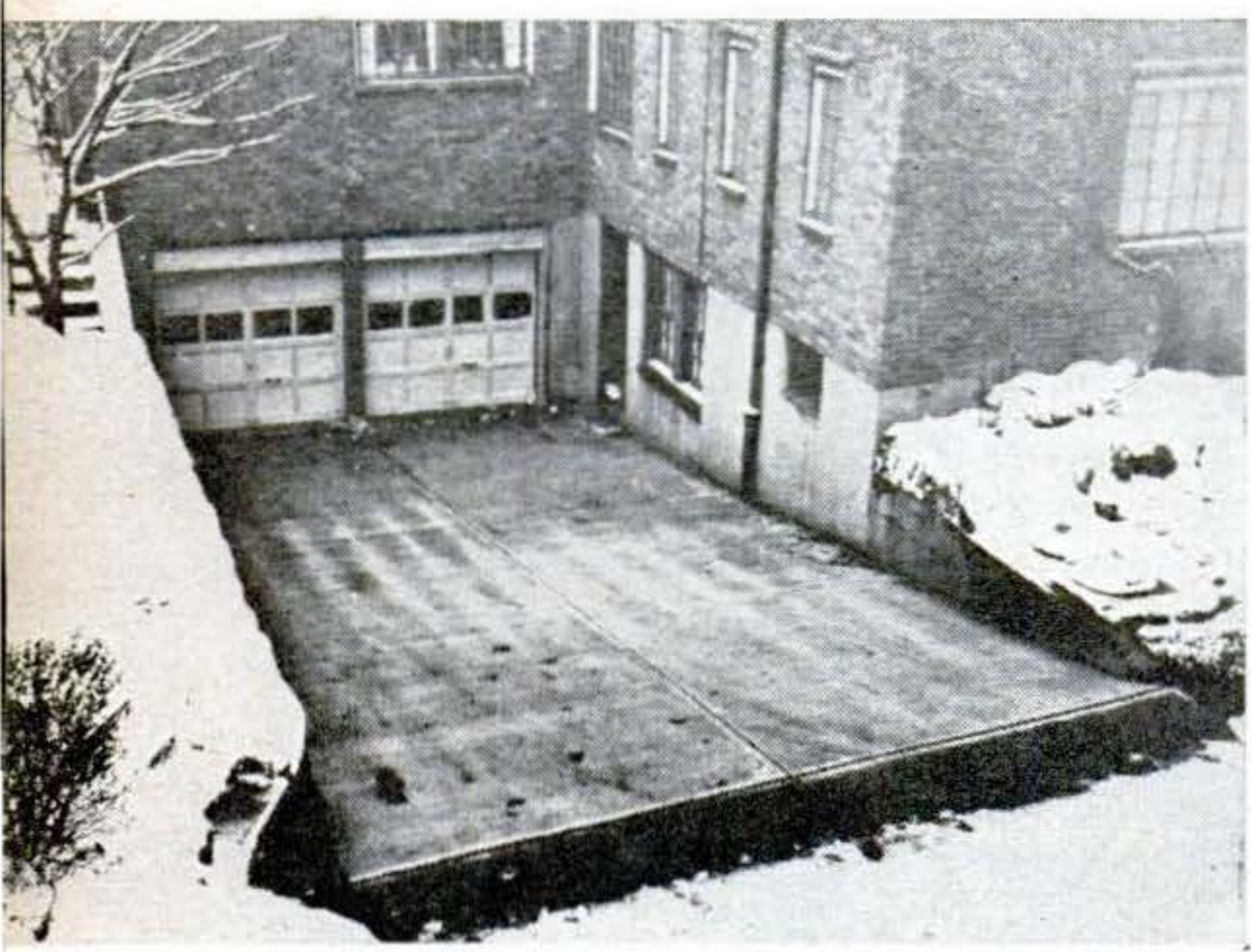
A HEATED driveway or sidewalk is a happy substitute for a shovel when the snow falls, but you can buy an awful lot of shovels for what one of these systems costs. Nevertheless, each winter more home owners and businesses are turning to this method of solving the snow-removal problem.

But they're still pretty much of a luxury. Installation costs run from about $1.50 to $3 a square foot, depending on conditions. For example, the one pictured at the left cost $1,200. The steeply sloping drive shown below cost more than $2,200.

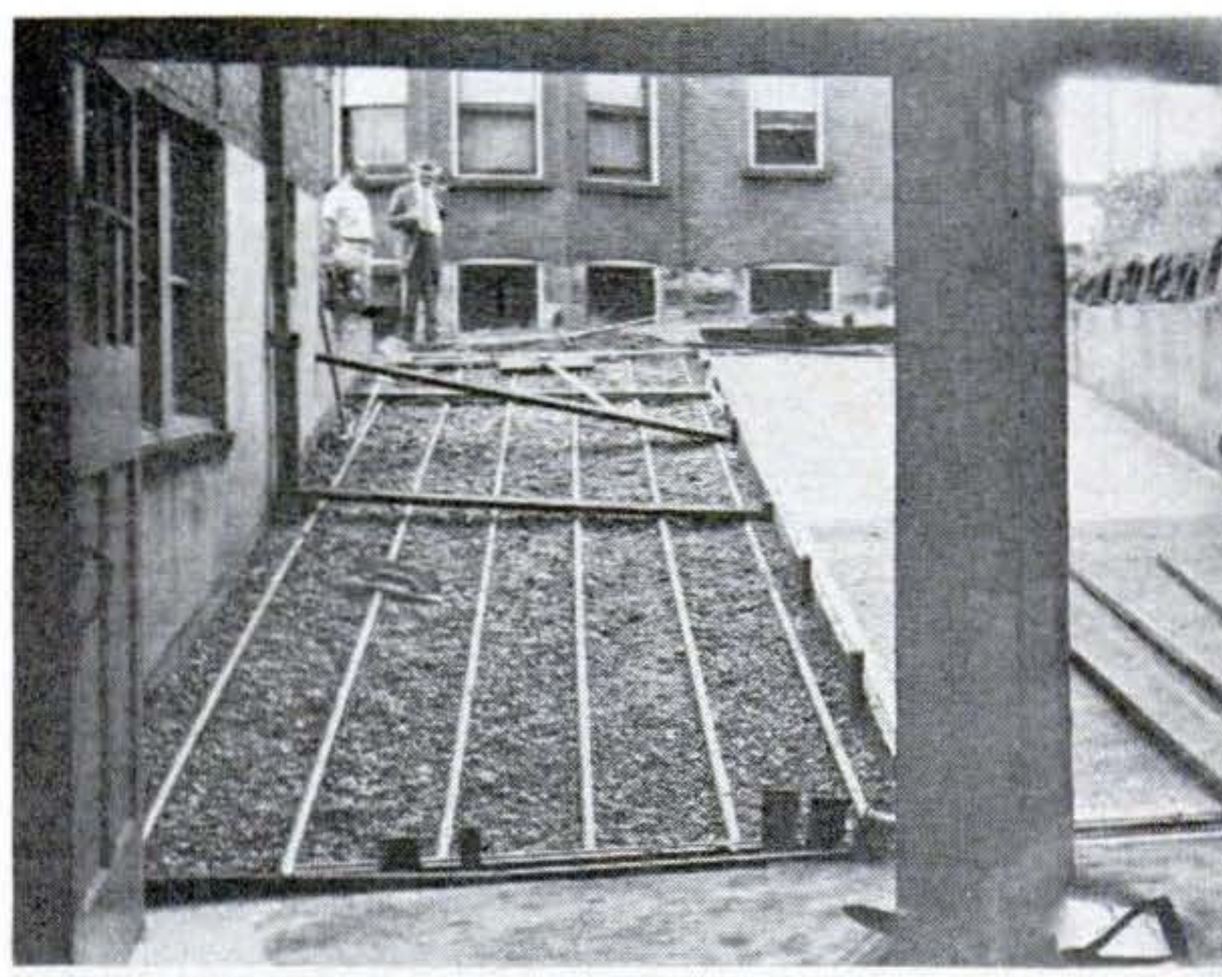
Most of them are essentially a hot-water heating system with antifreeze added to protect the pipes when the system is shut down during clear sub-freezing weather. They use a grid of welded wrought-iron pipes laid under the concrete, a water heater, and a pump to circulate the water. The set-up also includes an expansion tank, air-vent valve, and controls for heater and pump.

But if you're tempted to grab a pipe wrench and a boiler and put in your own heated driveway, you'd better think again. In the first place, if you've already got a drive, it means tearing it up and laying new concrete over the pipes. Secondly, planning the system calls for careful calculations by a competent heating engineer with a pocketful of formulas.

For instance, the engineer has to dope out the size of the circulating pump needed.



This steeply sloping drive, dangerous when ice-covered, is kept clear by hot-water system. At bottom of drive, drain carries off melted snow.



Same drive as in photo at left when it was partially completed. To heat this driveway, 12 runs of 1¼" iron pipe 42′ long were laid.

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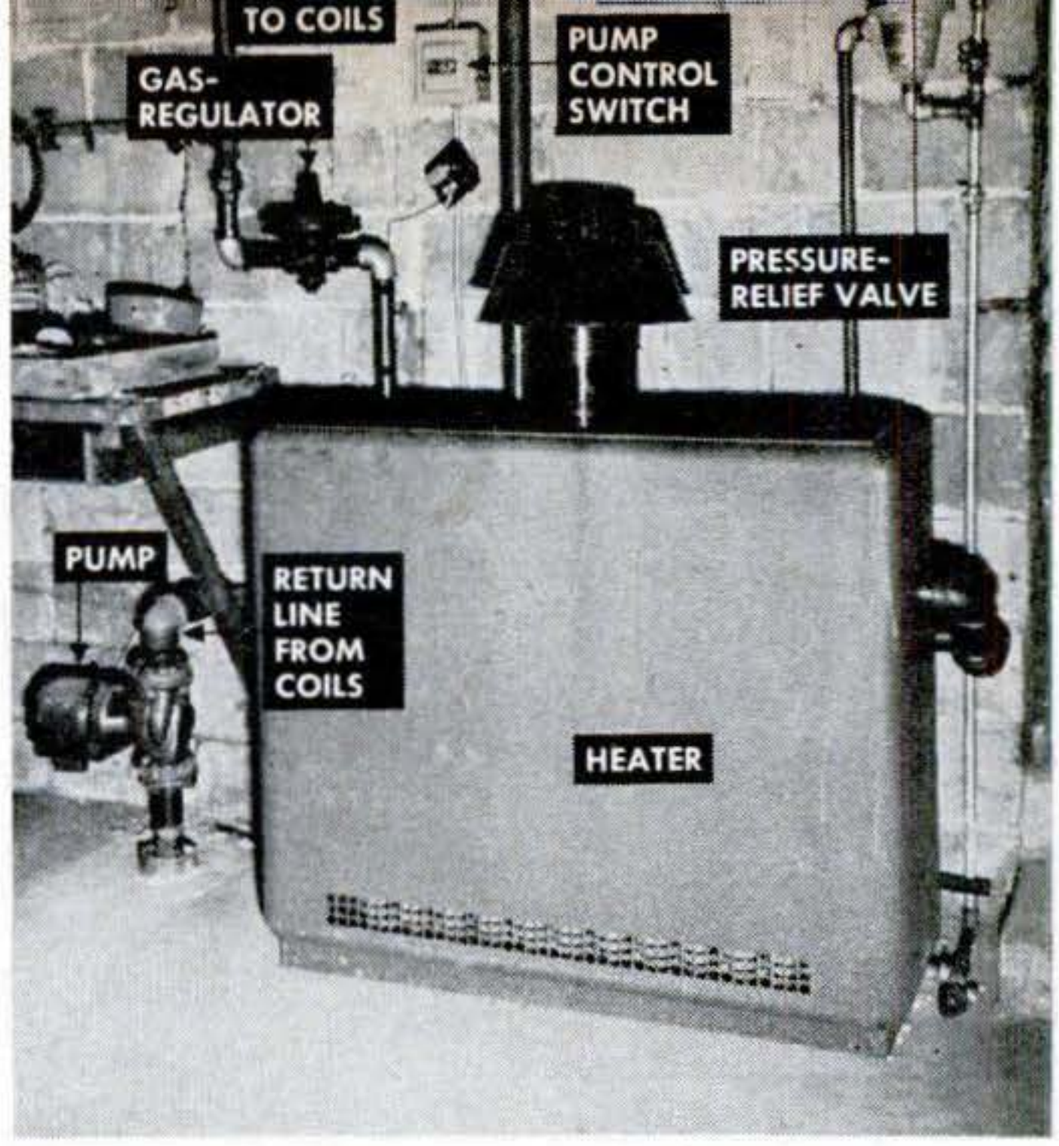
This depends on the size of the area to be melted and on how much heat you want to put into each square foot of driveway surface. Then if it's a sloping drive, the height the water must be lifted has a bearing on the calculations. Size of the expansion tank also must be figured; it runs between 10 and 15 percent of the system. About a third of the volume of the system must be permanent antifreeze, which can amount to quite an expensive item itself.

Two types of automatic controls are shown below. The one on the left starts the system when the pan fills with snow and tilts down. Holes in the pan prevent rain from starting the heater. The disadvantage here is that the system must be shut down manually. After the snow on the drive has been melted, the snow in the pan will continue to operate the heater. A variation of this control has a small heating coil under the pan that melts the snow at the same rate as the drive is cleared.

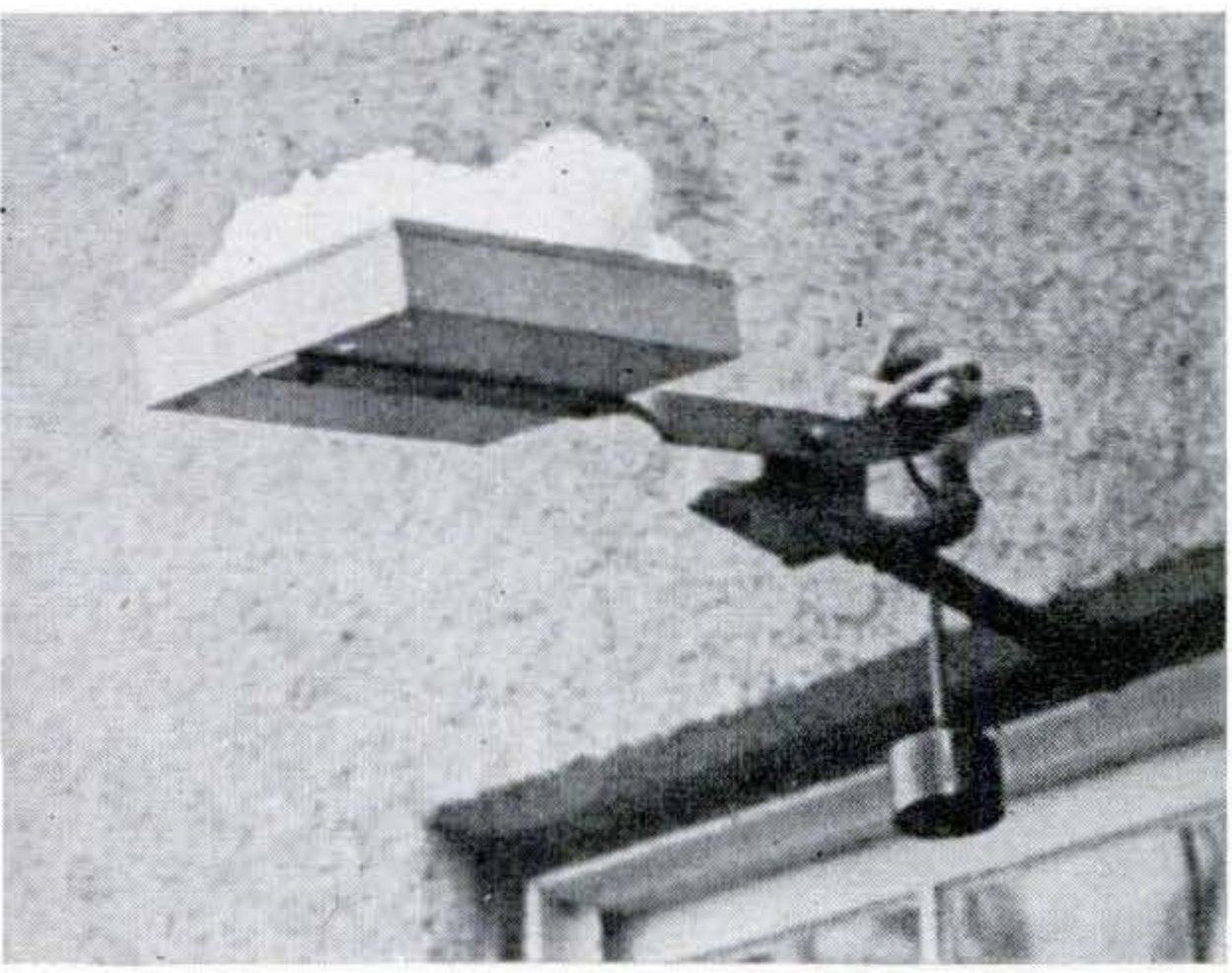
The photoelectric control, developed by T. Napier Adlam, West Orange, N. J., heating engineer, automatically starts and stops a heater and pump. Cemented to the surface of the drive, a polished plate reflects light into the electric eye, holding the system in an off position. When snow falls on the reflector, the rays are diffused and the system starts. Snow is melted from the reflector in the same time it is melted from the drive. When light rays again reach the photocell, the system is shut down. The plate is set at an angle so rain will run off and not start the heating plant.



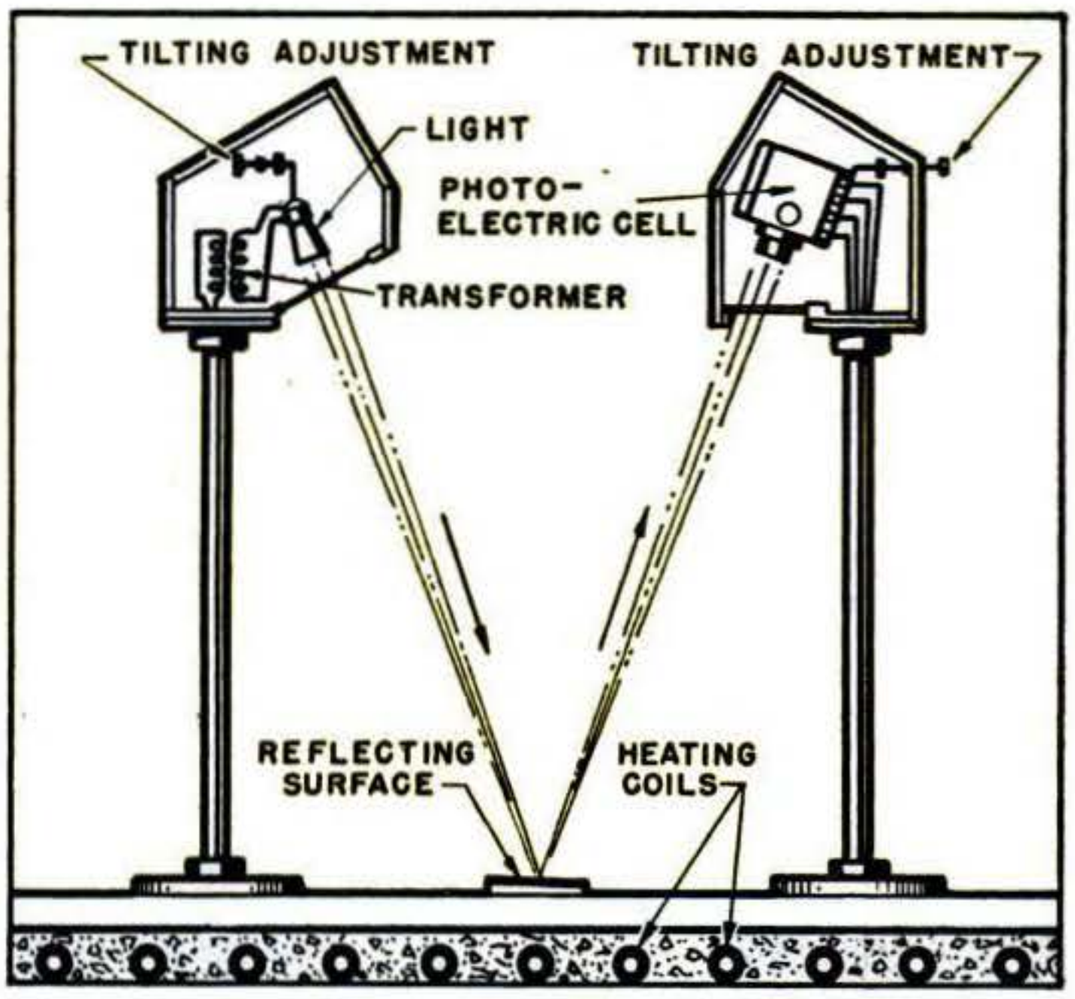
This is the heating plant for the driveway pictured at the bottom of the opposite page. The heater is a gas-fired type.

Steam has been used in some installations but it is not recommended by engineers unless the system is to be operated continuously. Condensate in the pipes can freeze when the heat is shut down. In one case, at a manufacturing plant, steam was tried. The condensate froze before reaching the extreme end of the line. They then switched to hot water and antifreeze.

Another, but not so widely used, method of snow removal is a soil-heating cable. The cable, a resistance wire, is housed in small-diameter pipe that is laid in the concrete. A drawback is that a 220-volt supply is needed if the cable is longer than 60′. END



Seesaw arrangement for starting snow-melting system. Pan fills with snow, tilts down, and starts burner. Holes let rain run through.



Photoelectric control holds heater in off position as long as reflector is clear. If snow interrupts light rays, a relay starts the heater.

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Tenons Build Strong Joints

For sagproof corners on your cabinet frames and doors, use close-fitting mortises and tenons. Here are the simple steps for making them by hand.

By Edwin M. Love

AMONG woodworking craftsmen the mortise and tenon-joint is a synonym for strength. If it needed any testimonials, you would only have to recall that our forefathers used it in framing their houses—and they built for a century or more of service. Nowadays its familiar—and almost indispensable—uses are in panel door construction, joining rails or aprons to table legs, making window sash, and a multitude of other structures where frames must have rigidity without the addition of diagonal supports. You'll not build much conventional furniture in your shop without using mortises and tenons.

The simple form of mortise and tenon, illustrated in Fig. 1, makes a strong corner for a door-hanging frame on the front of a cabinet. It is of course desirable to get a good fit at the shoulder, where it will be open to inspection. But it is just as essential that the tenon fit the mortise snugly, not only to secure a strong glue bond but also to stiffen the frame against diagonal racking.

Prepare for making the joint by squaring the lumber. Identify the working faces with penciled crosses or by some other convenient marking, and cut the pieces to length. To figure the length of the rail stock (the horizontal members), first determine the total width of the frame and then subtract one-fourth the width of each stile or outside vertical member. This is based on the common practice of making the length of the tenon three-quarters the width of the stile.

In making a frame for a door or panel, rail and stile lengths are governed by the door's dimensions. For the rails, add to the door width the length of two tenons. Stiles are similarly measured as the height of the door plus the width of the rails.

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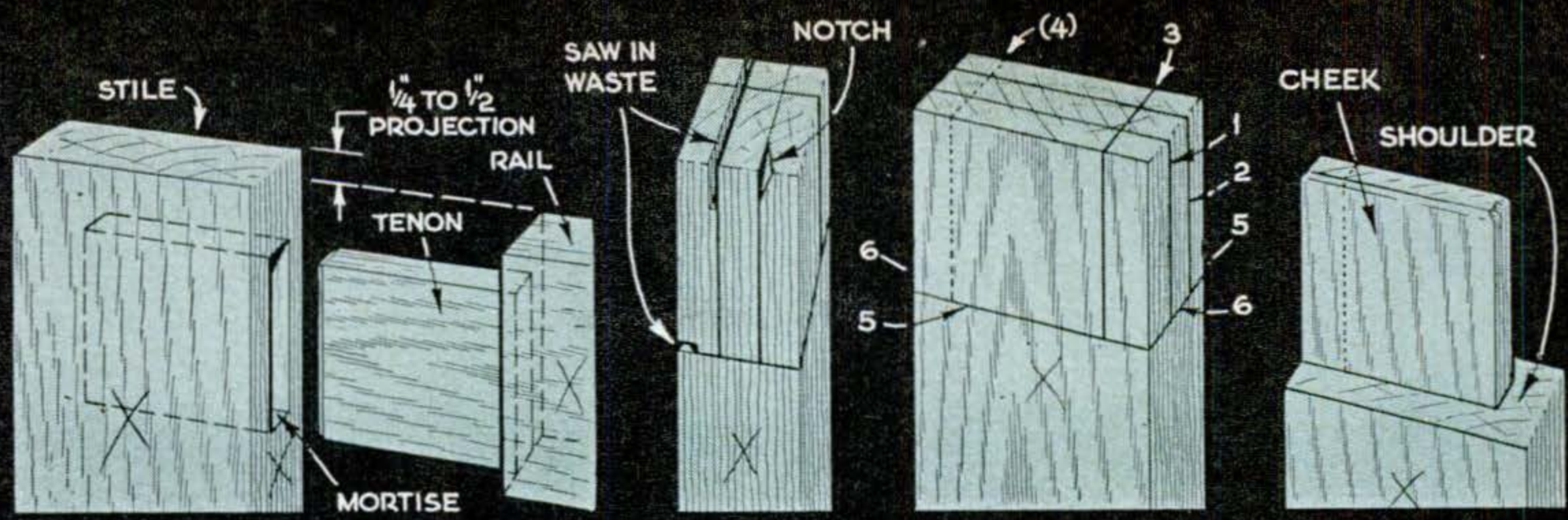


SIMPLE MORTISE AND TENON JOINT

1

The numbers indicate the sequence of tenoning cuts. Sometimes only one edge is shouldered.

In both cases allow about ⅛″ for paint and working clearance. This margin is either added or subtracted, depending on whether the frame is for the outer casing of the door or for the door itself. Allow ¼″ to ½″ working projection at both ends of a stile to strengthen it against splitting as the tenons are forced in.

Ordinarily in a frame of this kind the inner edge of the tenon is flush with the inner edge of the rail. The width of the tenon is about three-quarters that of the rail. If the frame is divided into two or more openings by internal stiles or muntins set in between the upper and lower rails, the tenons can be made either full width of the muntins or shouldered on one or both edges as indicated by the dotted lines in Fig. 1. Shoulders increase the stiffness of a joint.

Scribe the shoulders of a tenon with a knife point as in Fig. 2. Mark the face side, the edges, and the back face in that order, and then center the tenon on the thickness of the rail. Make the tenon a little thicker than one third. By using a marking gauge as in Fig. 3, and then marking off the corresponding mortises with the same gauge setting, a proper fit of mortise and tenon is made more likely.

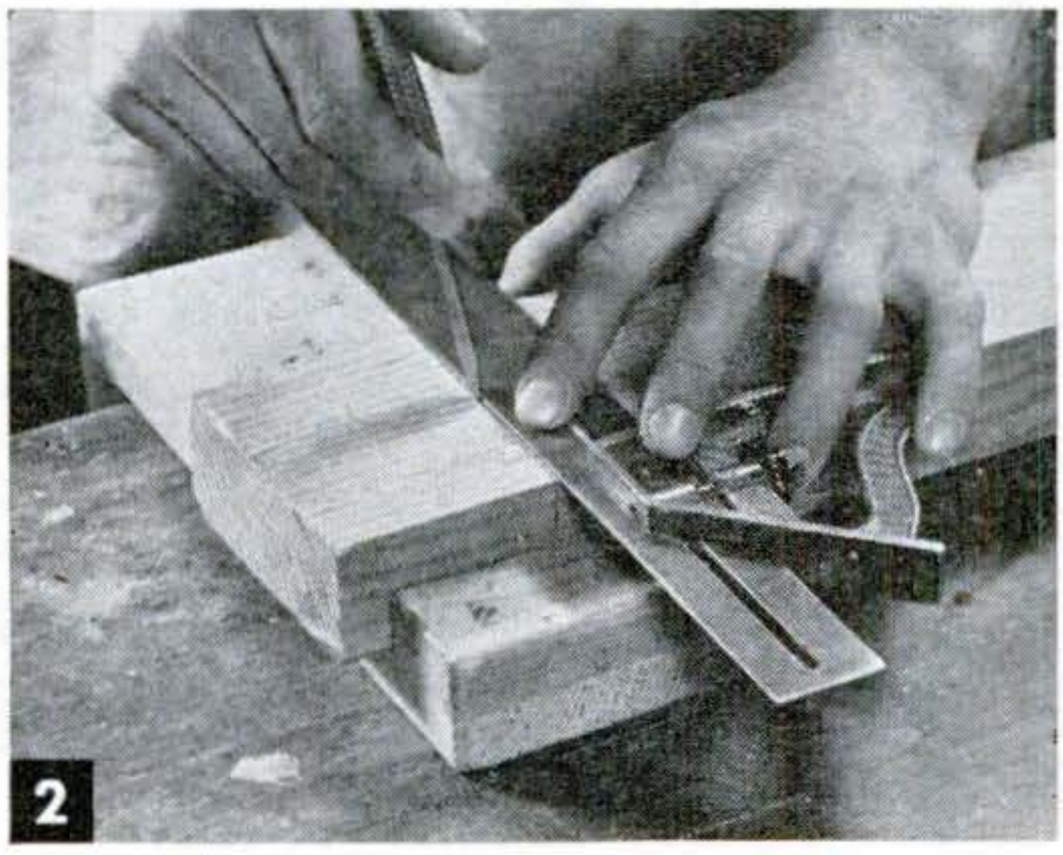
Figure 4 illustrates the start of sawing a tenon cheek. Steady the blade with the forefinger or thumb of the left hand until the cut is well started. Some workers extend the forefinger of the left hand along the side of the saw handle to stiffen the grip, and make a knife notch to help start the cut. Grazing the line while cutting in waste wood is desirable for a true tenon. Once the saw is well into the cheek, level it off. Correct any tendency to stray from the line by ripping down one edge and finishing the cut from the other edge. The order in which tenon cuts are made is indicated in Fig. 1.

Support the work on bench hooks while sawing the shoulders. Start as pictured on page 248, level off, and cut through the waste. Saw the edge shoulder or shoulders last. Chamfer tenon ends.

Handmade mortises are produced by boring or chiseling, pictured in Figs. 5 and 6 respectively. For the former, gauge a center line and make a hole at each end. Follow with overlapping holes between and clean up the sides and ends with chisels as in Fig. 7. Make the mortise depth a little greater than the tenon length.

To chisel out a mortise without first boring holes, incline a series of cuts toward the center. Hold the bevel down and strike sharp blows with a mallet. Clear the shavings by prying toward the center with the chisel. Finish the mortise with the chisel held vertically, the bevel toward center (Fig. 6).

Many cabinet doors and ends are made



2

With the rail held securely on a bench hook, scribe the shoulders with a sharp knife point.

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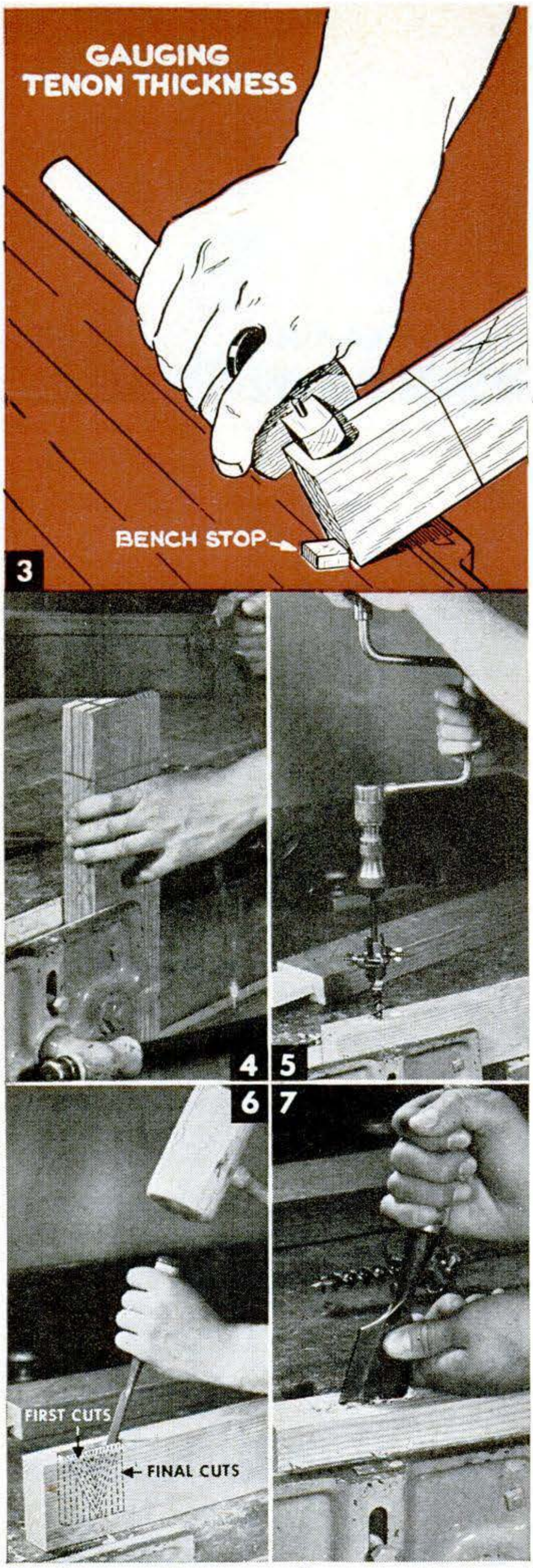

Mark tenon thickness with a gauge (top), and use the same setting to scribe the mortise. Cut the tenon first, and drill or chisel out a close-fitting but slightly deeper mortise.

with panels held in grooves in the frame. Make the mortises and tenons before plowing the grooves in the inner edges of the stiles and rails. Haunch the tenons of the top and bottom rails to fill the groove ends as in Fig. 8. The length of the haunches must be exactly equal to the depth of the grooves. When using a plywood panel, make the groove equal in depth and width; for a solid panel it should be a little deeper.

If you are building a Colonial cabinet you may wish to add to the authenticity of your craftsmanship by using draw pins. You'll find them handy, also, when you want to put a frame together without glue so that it can be taken apart when the need arises. Bore small holes (3/16″ or ¼″) through the mortises and corresponding holes in the tenons. The latter are offset a trifle closer to the shoulders (Fig. 9). Traditionally the pin is a square stick with the corners whittled off. When driven into the offset holes, it pulls the joint tight.

It is possible to increase the strength of a mortise-and-tenon joint by undercutting the ends of the mortise and wedging the tenon to fill out the extra space. This foxed joint is illustrated in Fig. 10. Make the tenon in the ordinary way and drive wedges into saw kerfs or chisel splits in the end. To assemble, apply glue to the tenon, mortise and wedges. Start the wedges into the kerfs and enter the tenon in the mortise. Clamp pressure forces in the wedges. The shoulder ends must fit closely to prevent splitting beyond the tenon. Test the shoulder fit without the wedges, and don't try out the completed joint before gluing it, since it's almost impossible to take apart. The extra strength that is possible with this joint is largely lost if the wood is poorly seasoned, because the edges will shrink away from the mortise ends.

When door rails are wider than 3″, a double tenon (Fig. 10) is sometimes used. Remove the center of a wide tenon by boring, ripping, and chiseling the bottom.

A doweled joint can be made more quickly than a corresponding mortise and tenon, but is usually considered a little weaker because of the difficulty in boring the holes accurately. (Hard grain may deflect the auger bit or even cause it to drift.) The round dowel also lacks the effective gluing surface of a tenon.

Ease of fabrication partly offsets these disadvantages. On the credit side one must also count the possibility of using hardwood dowels even when the lumber is soft, and

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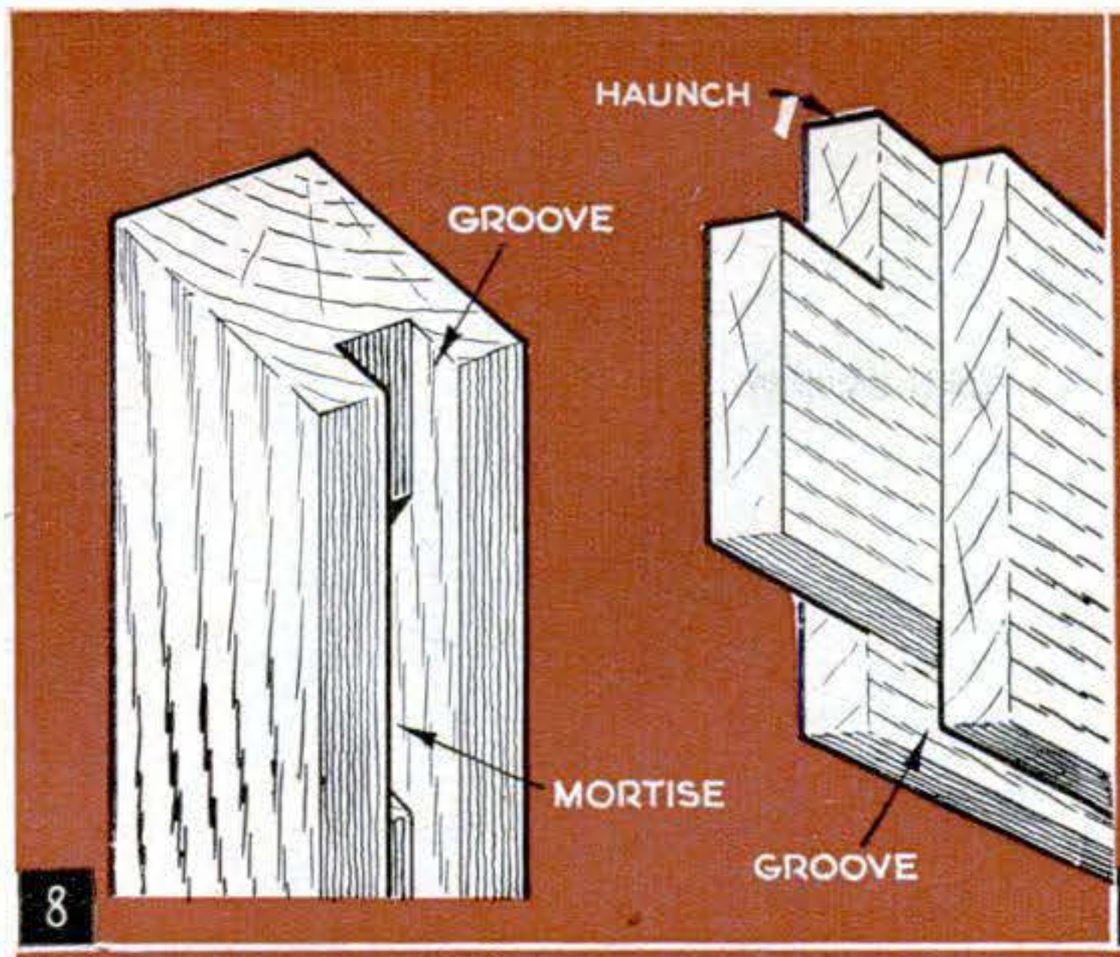
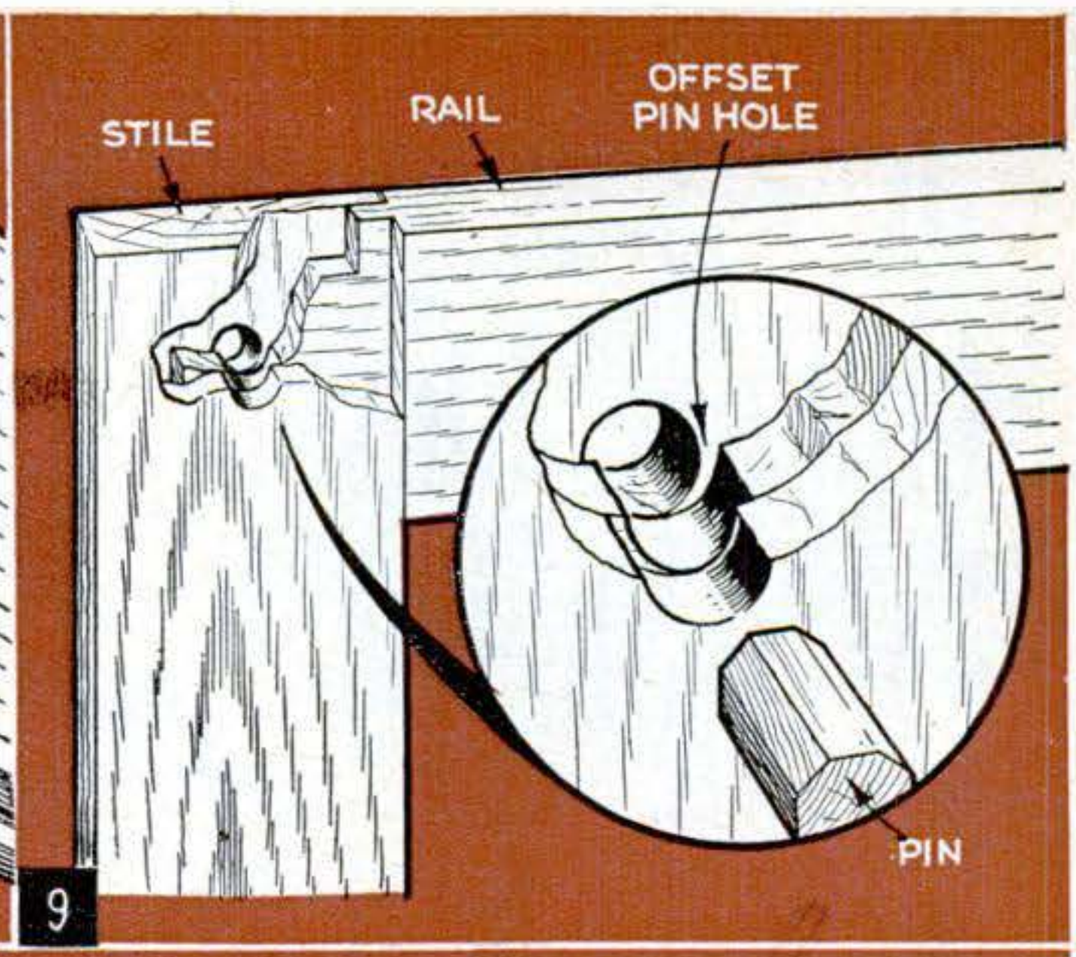
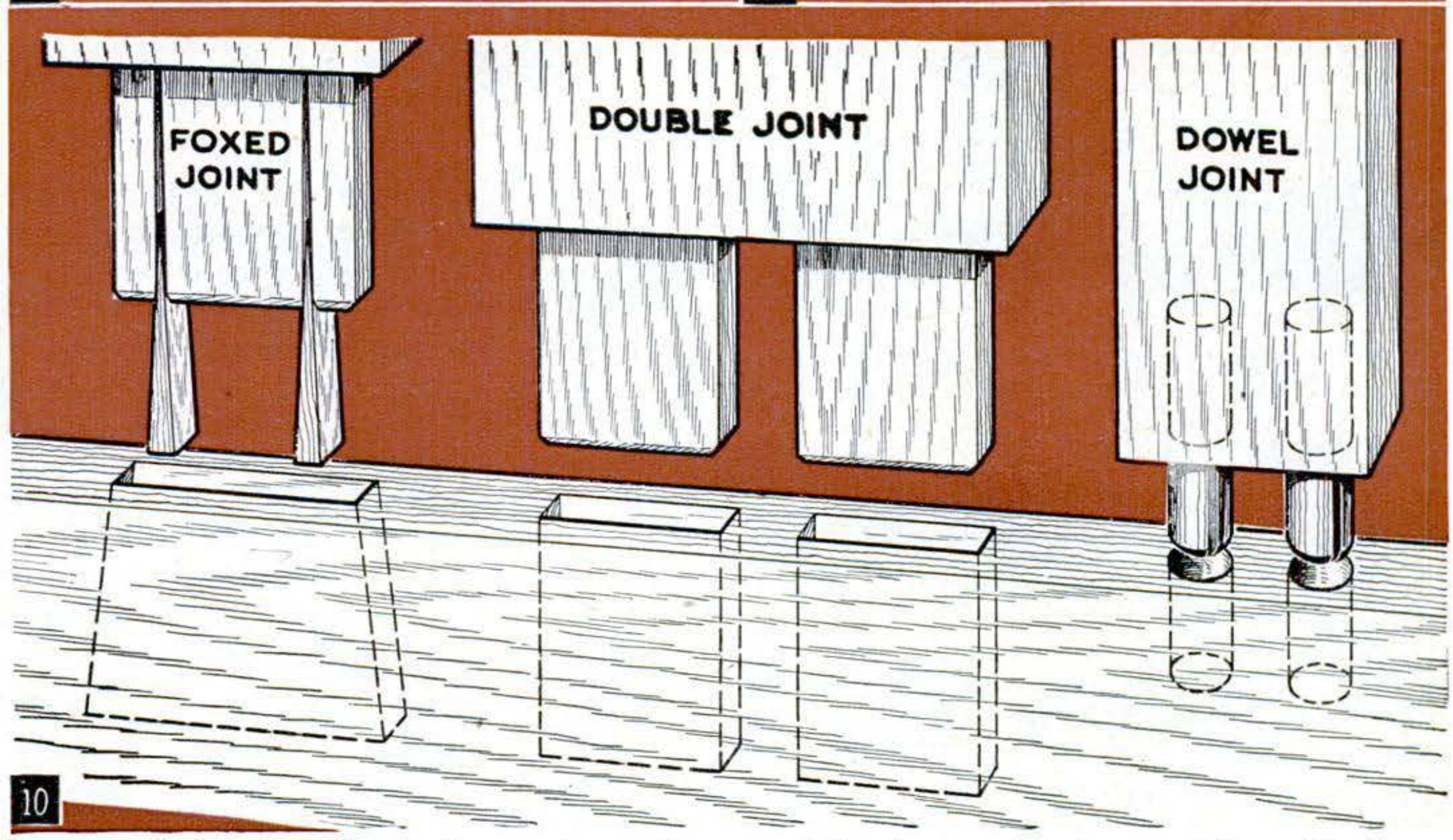




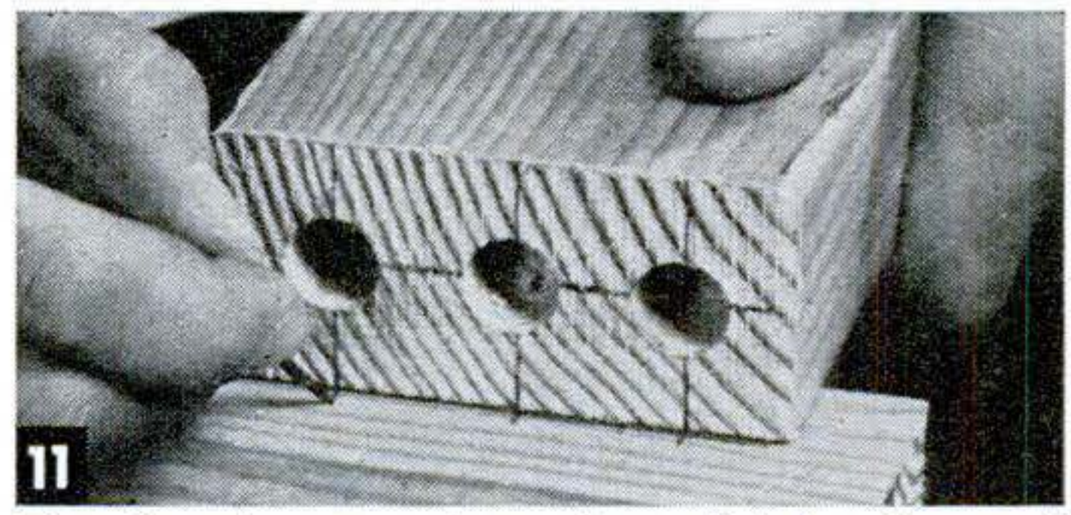


These variations on the basic mortise and tenon joint have value in special applications.

the fact that a stile bored with a series of holes is likely to be more solid than one hollowed by an elongated mortise. Doweling technique is the same as that described for edge gluing (PS, Dec. '48, p. 229). Mark and bore the rail and use it as a guide for spacing dowel holes in the stile (Fig. 11).

A pair of dowels in the end of a square member may be better placed on the diagonal rather than centered. And in very thick stock, two rows may be used. Tenons too may be offset, or the mortise—as in a table leg—may be set back to allow the leg to project in front of the apron. In heavy construction the apron tenons can be made flush with one face and nearly as thick as the apron itself since there is ample stock in the leg to accommodate the wider mortise.

Despite all your care, you will often find it necessary to work down the face of the stile or rail to make the two parts come flush. If there is considerable offset, use a smoothing plane or scraper; in most cases a little careful sanding is all that's needed. END



For dowel joints, bore the rail holes first and use them as a spacing guide for the stile.

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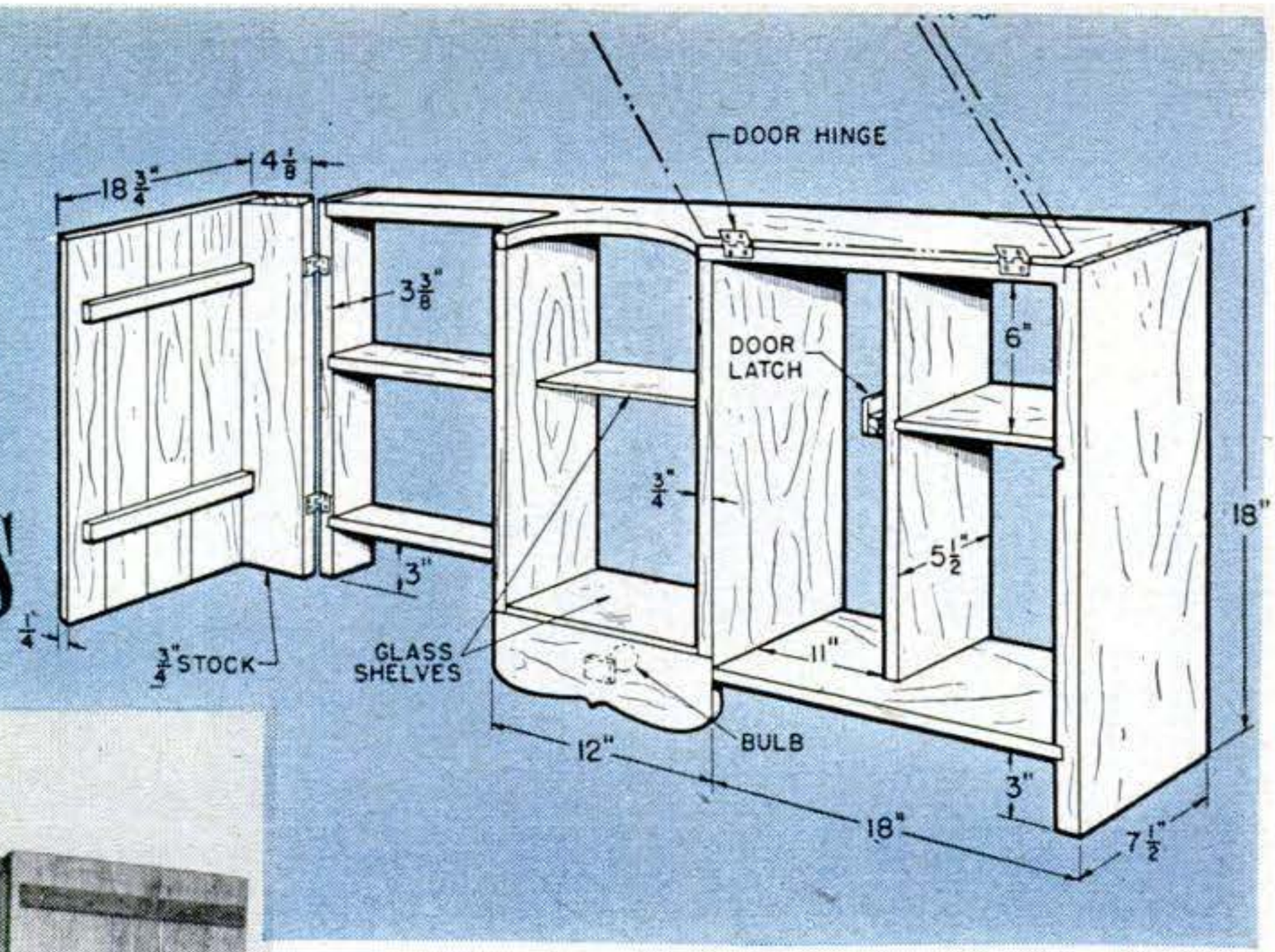
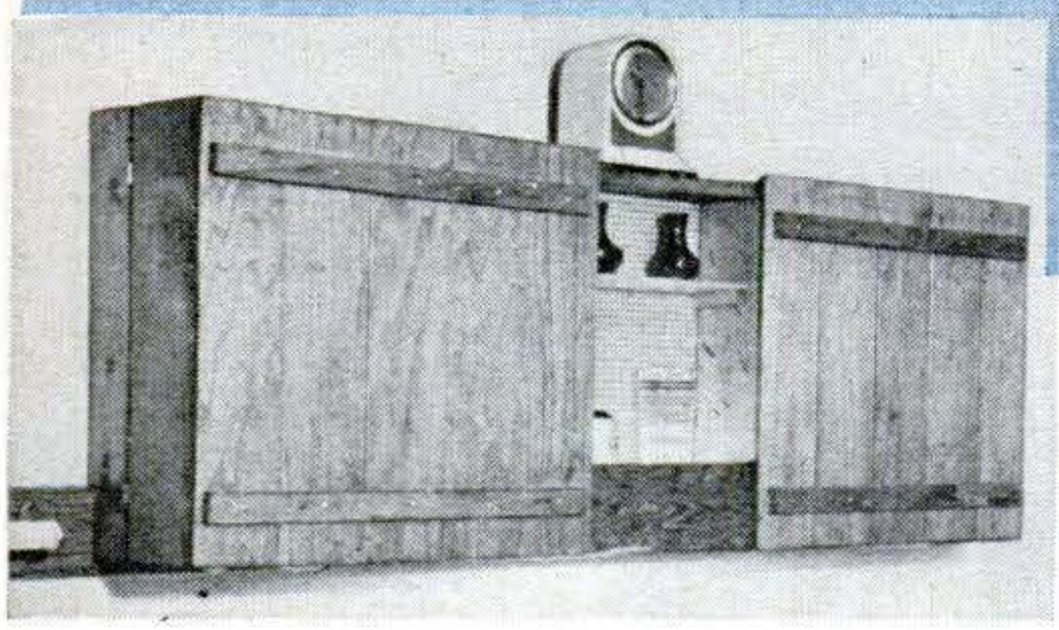
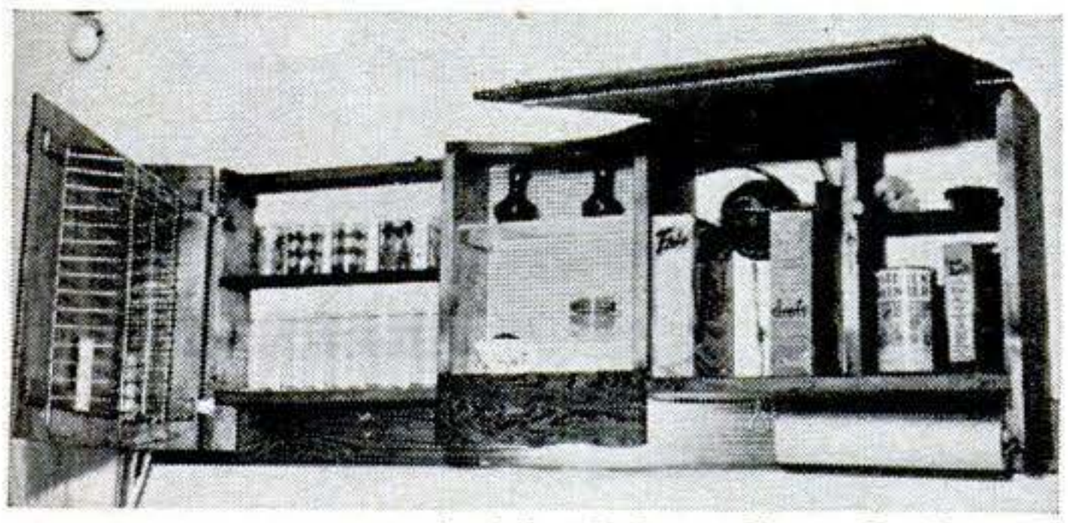
Over-Sink Cabinet Adds Extra Shelves

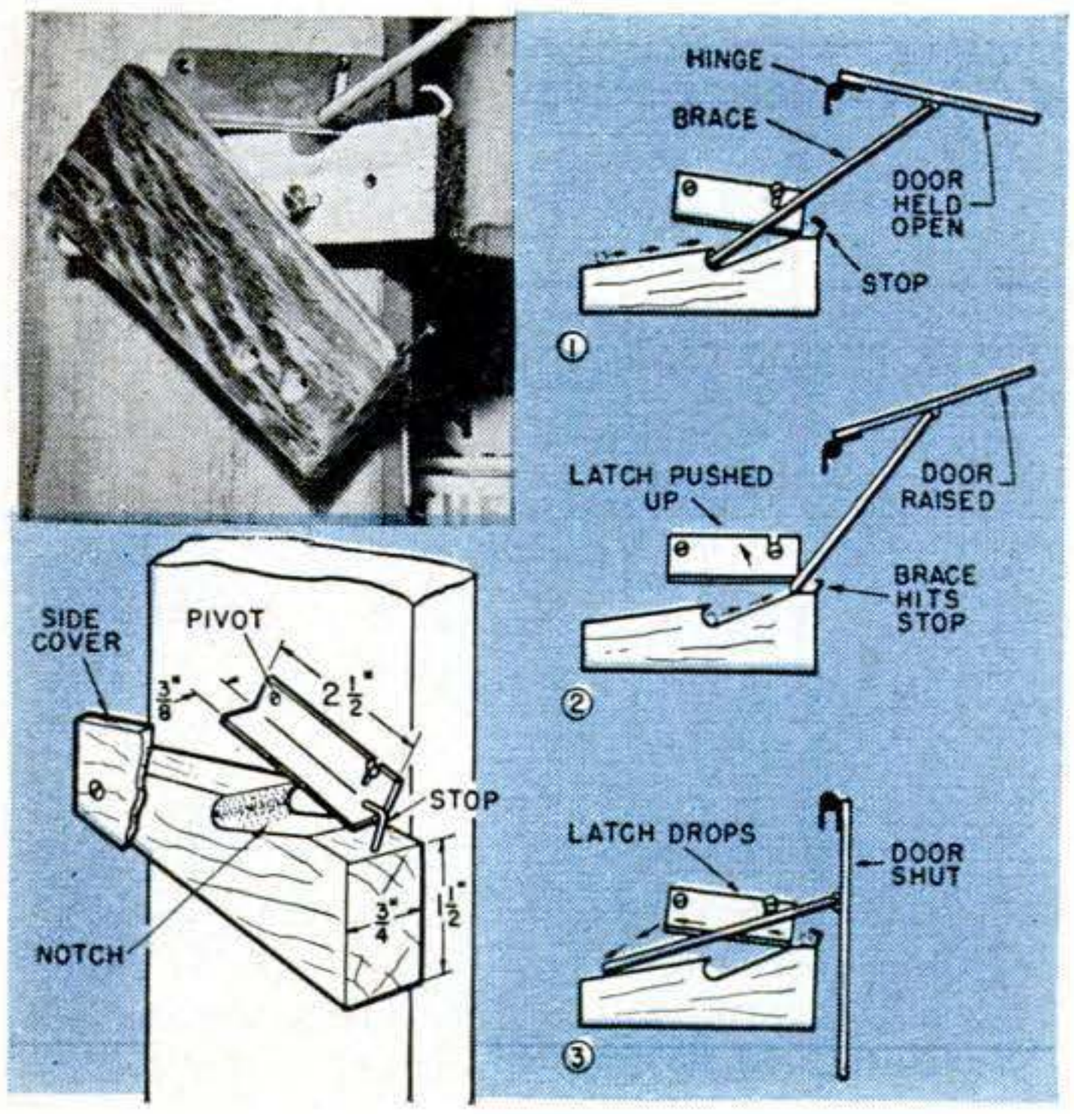




In the center of the cabinet, the whatnot section is lighted by same lamp that lights sink.



Cupboard at left holds dish rack and glasses. Below are details of the latch construction.



A NOTABLE feature of most kitchen cabinets are the doors on which you bump your head. They always seem to hang open at just the right height to hit you. This cabinet has one big advantage. The right-hand door hinges at the top so it swings up and locks out of the way. You'd have to be walking on stilts to bump into it. The other door also is kept out of the way—a spring closes it as soon as you let go of it.

The operation of the automatic catch that holds the door up out of the way is simple. When the door is opened, the weight of the brace rod drops it into the notch, holding the door up. To close the door, lift it another inch or so and the sheet metal return piece drops into place. The brace rod then by-passes the notch as the door is closed.

The main dimensions are on the drawing at the top of this page. Although the doors can be opened by pulling at the overhang on the bottom of each one, handles may be added if you wish. Brass-headed upholstery nails were used to cover the heads of the finishing nails that actually hold the door slats. I "worm-holed" the exterior with a small gouge, stained it, and rubbed it down.

Red checked oilcloth covers the back of the whatnot section. The light filtering up through the glass shelves reflects on this and produces a warm, bright glow. I plugged the concealed light into an outlet that was already there, eliminating any extra wiring. If you want, you can just skip the lamp. However, if you use one, be sure the leads are polarized correctly and the pull chain has an insulating link.—*Robert Hoppough, Waukegan, Ill.*

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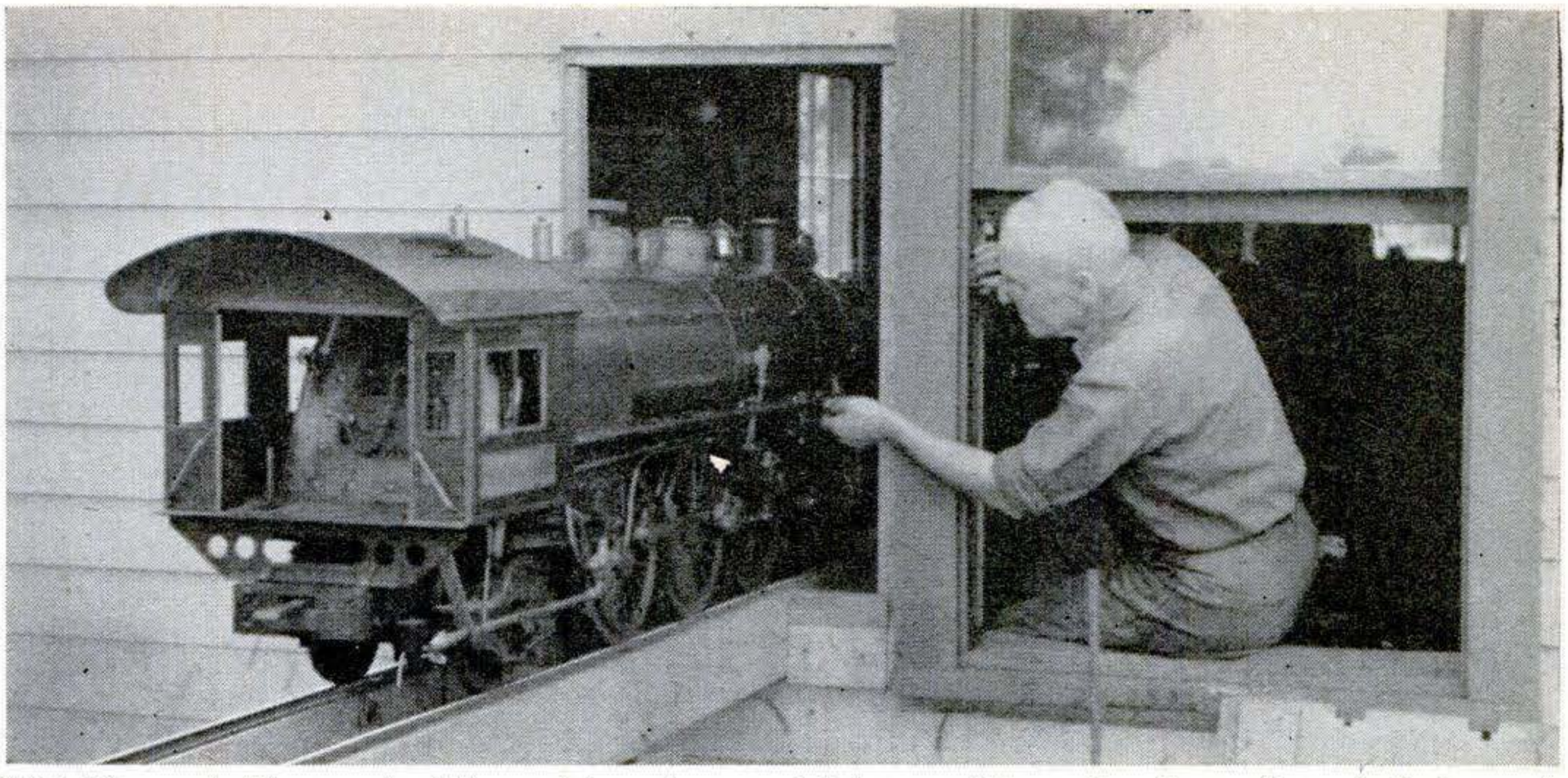


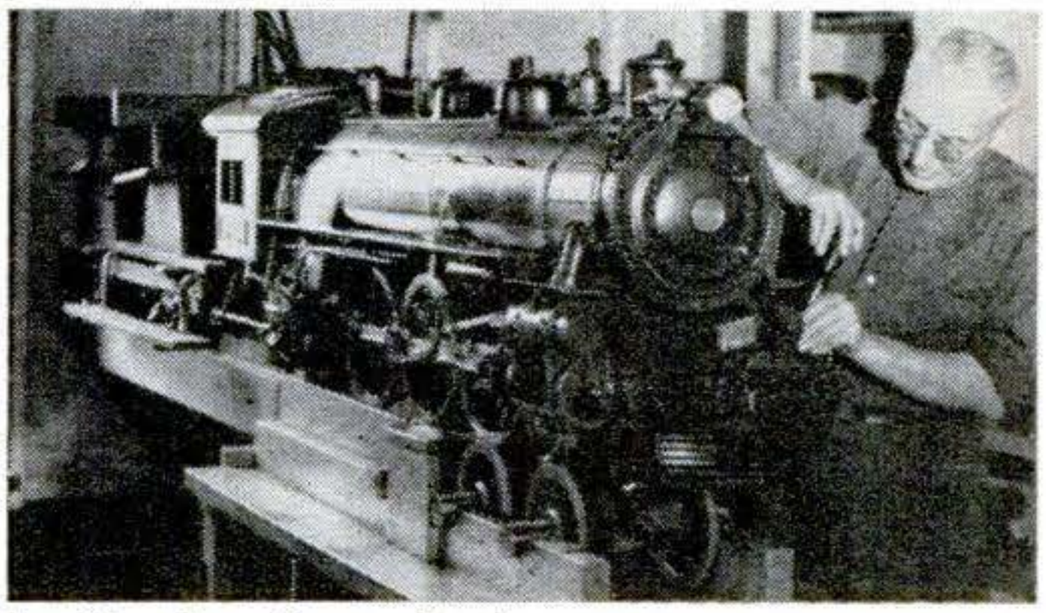
Weighing a half ton, the big coal-burning model is eased into the shop where it is housed.

Super Live Steamer Rolls into Home Shop

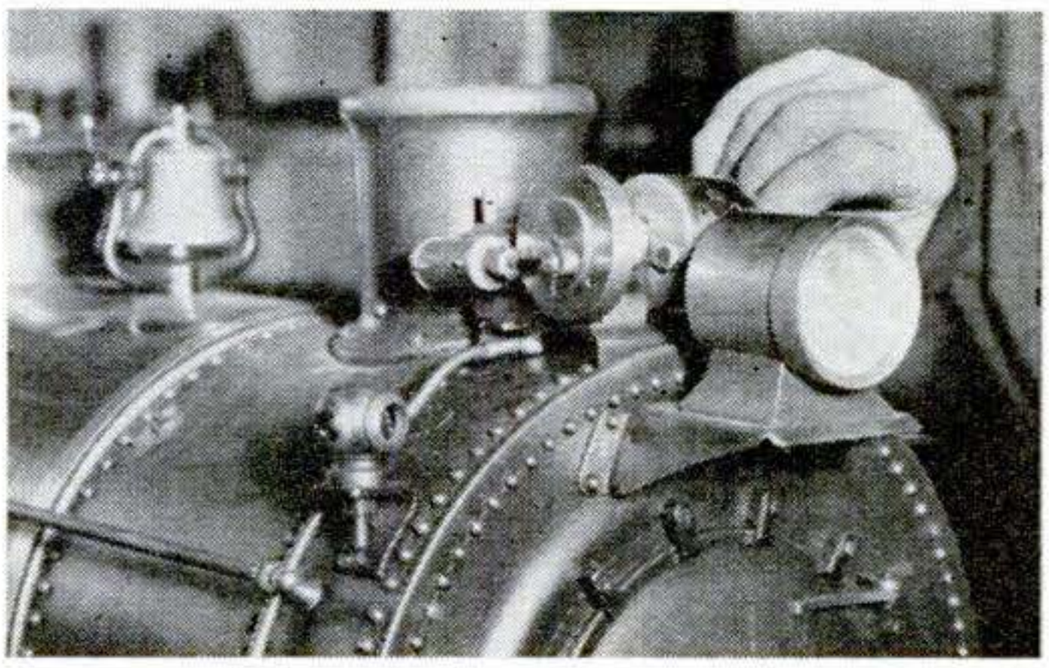
THIS king-size model—a reproduction of a K-4 Pennsylvania Railroad locomotive —is 11′ long, weighs 1,000 lb., and operates on 100 lb. steam pressure. Pictured here with its builder, Frank W. Brown, of Ravenna, Ohio, the engine runs on 7¾″-gauge track laid on Brown's 11-acre property adjoining his machine shop.

Each part is built to exact scale, 1½″ to 1′. A feature that attracts much attention is the tiny steam-driven generator perched at the forward end of the boiler just behind the headlight it powers. Brown rebuilt a bicycle generator to make this unit. The coal burning locomotive is housed in the shop, which it enters through its own special door.

Brown, who previously had built other working models of locomotives, spent five years working on the K-4 in his spare time.

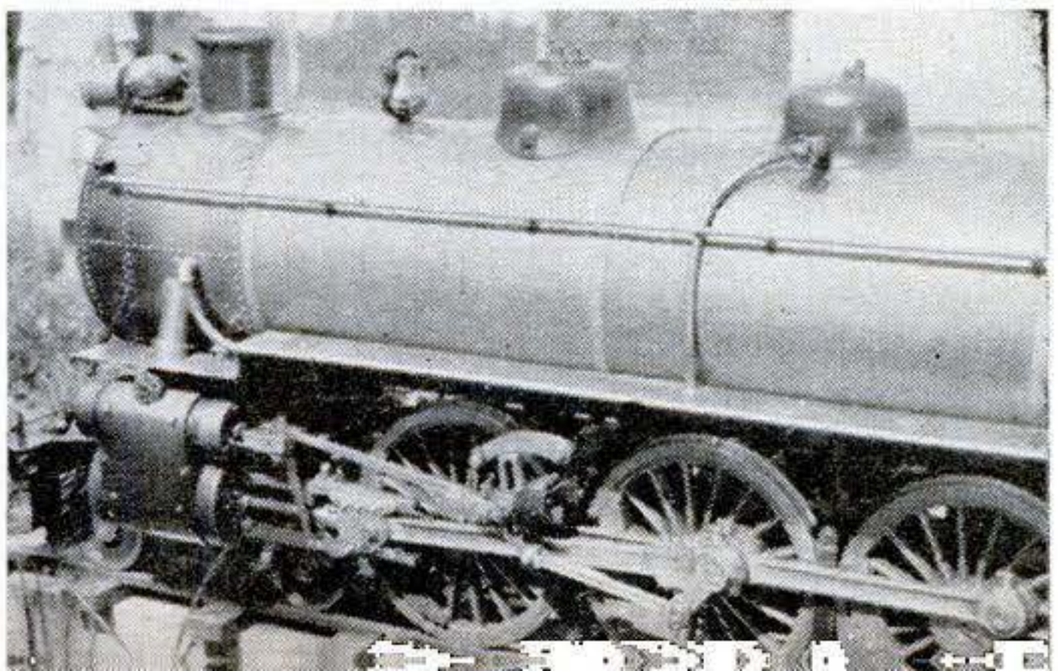


Inside the shop, the locomotive rests on a set of wheels that match and turn with the drive wheels, permitting test runs indoors.

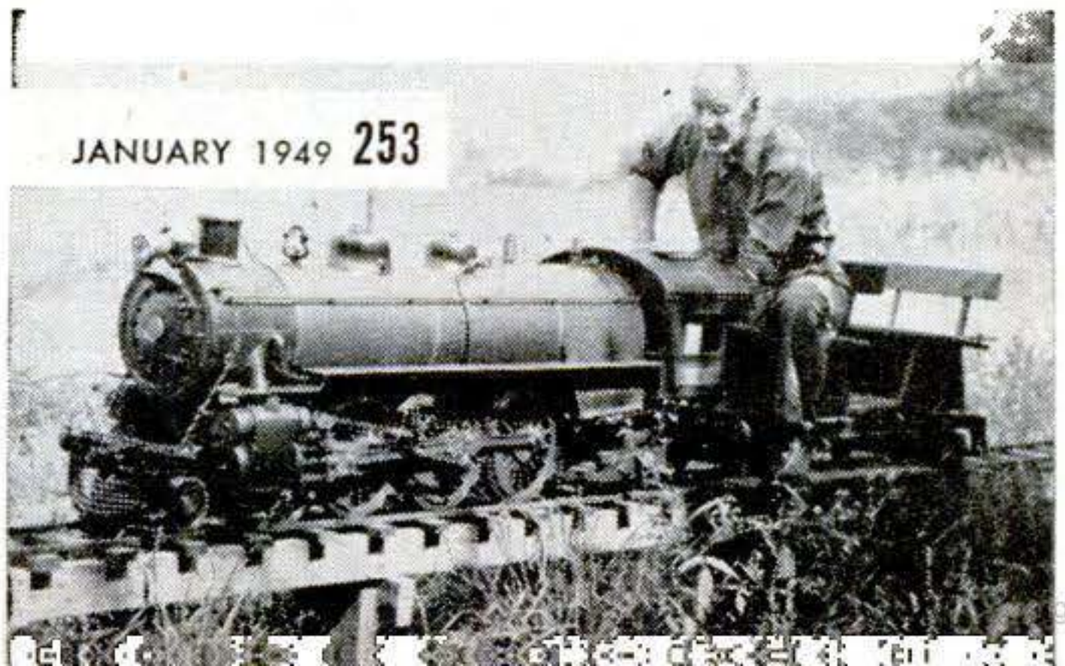


Electricity for the headlight is generated by this little one-cylinder oscillating steam engine, driving a converted bicycle-light dynamo.

Close-up of drive wheels and cylinders shows the exacting workmanship that went into the construction of the locomotive.



Out for a spin, the builder, Frank W. Brown, is both engineer and fireman. The scale model chugs along over a 7¾″-gauge track.



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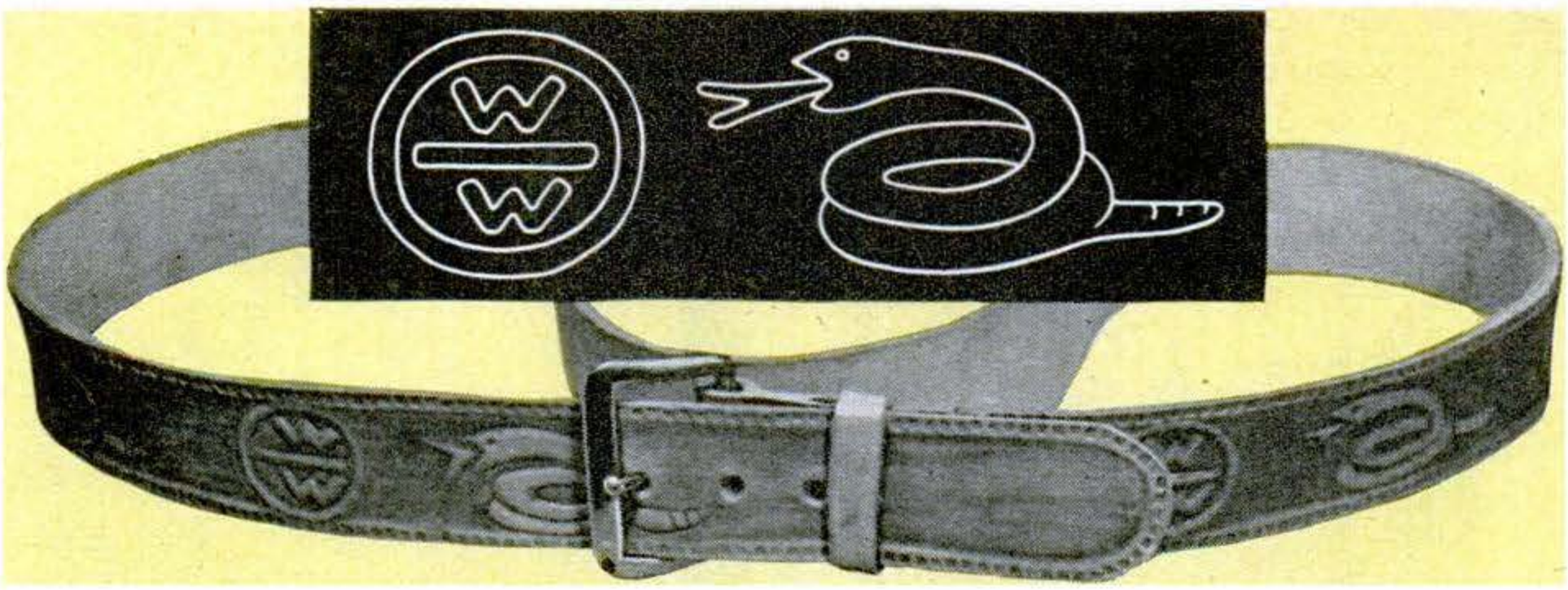
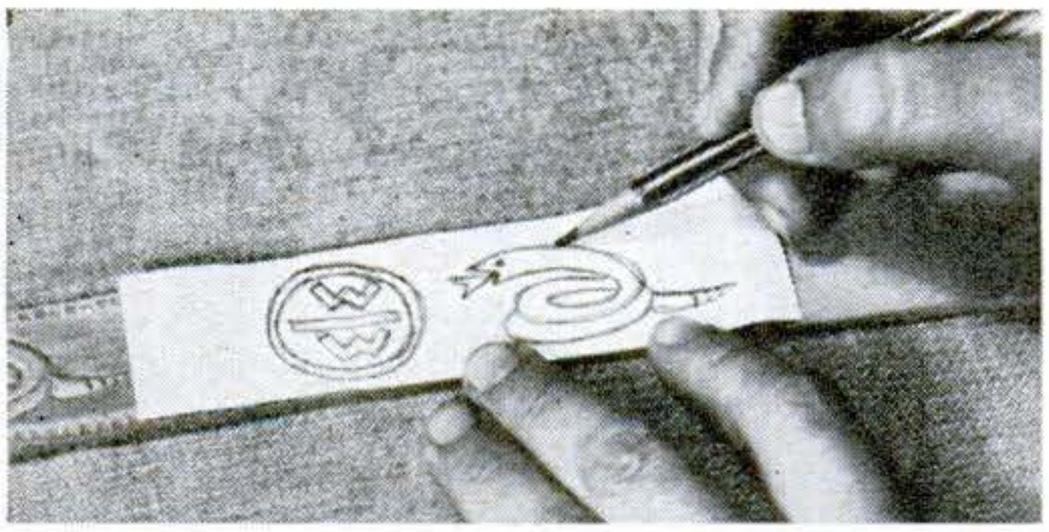


Ranch Brand Tooled on Belt

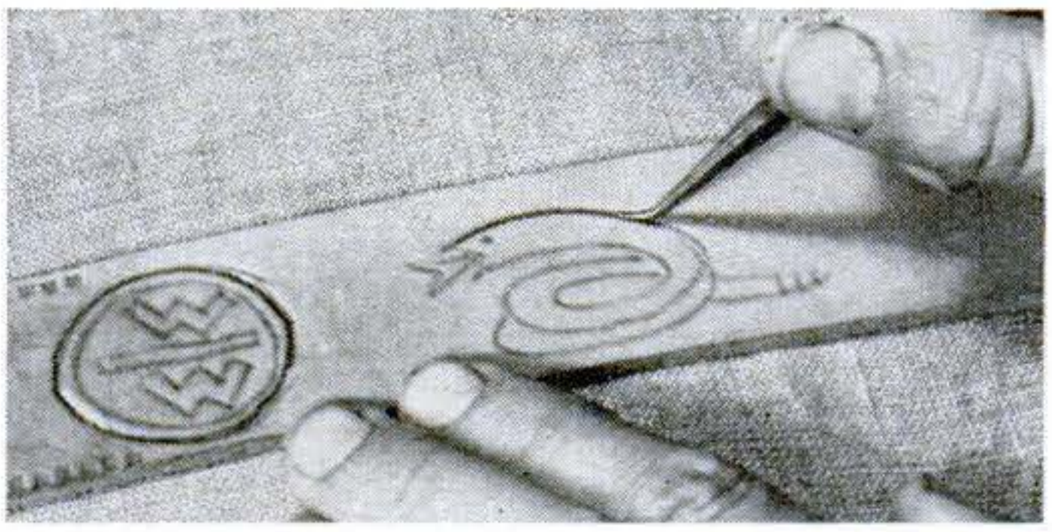
THIS hand-tooled leather belt has a real Western flavor—a coiled rattlesnake and a ranch brand with your initials. Only simple tools are needed. In fact, you can make one of them from an ordinary nail. Belt strips are available in several widths from craft supply houses.

The design along the edges is stamped with a nailhead. First file the head square. Then file two grooves at right angles across the head, dividing it into four sections. Lay the stamp on the edge of the belt with just two sections on the leather, the other two off. Hitting the point of the nail with a hammer makes two square marks.

Dampen a section of the belt and trace the design from a paper pattern. Deepen the lines with a pointed tool. Then work down the background with a ball-pointed modeling tool. This makes the design stand out. Use a strip of lighter leather for the loop. Attach it when you attach the buckle by either riveting or by cementing and clamping.—*Elma Waltner, Hurley, S. Dak.*

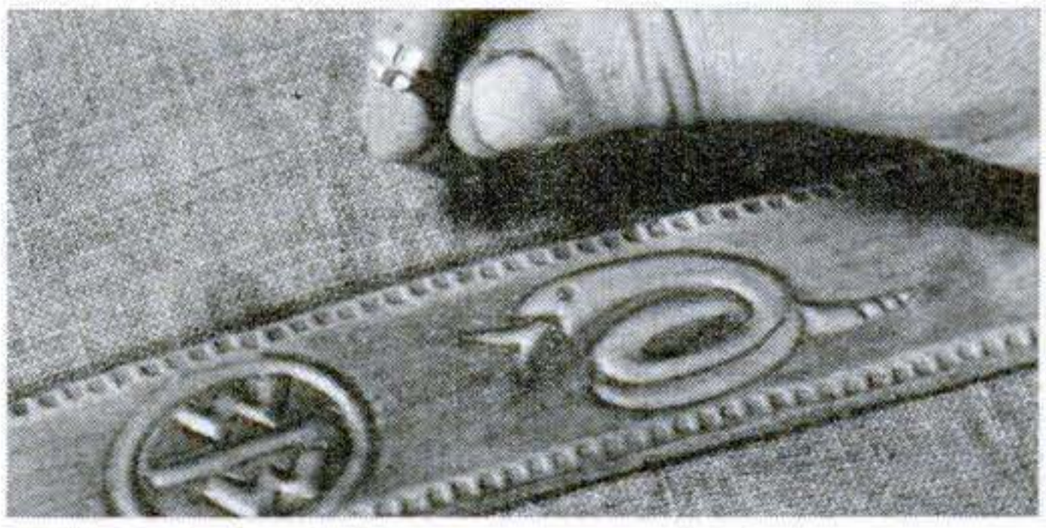


Lay out the brand and snake design on a piece of paper. Dampen a length of the leather and trace the design on it with a pencil.



After tracing the design, deepen the lines with a leather-working tool or a nutpick. Do not wet the leather too much. The design won't take.

By pressing down the background all around the designs, the snake and brand are made to stand out in bold relief.



With the tool made from a nail, stamp the design in the edges as you go along. Complete a section at a time before moving to the next.

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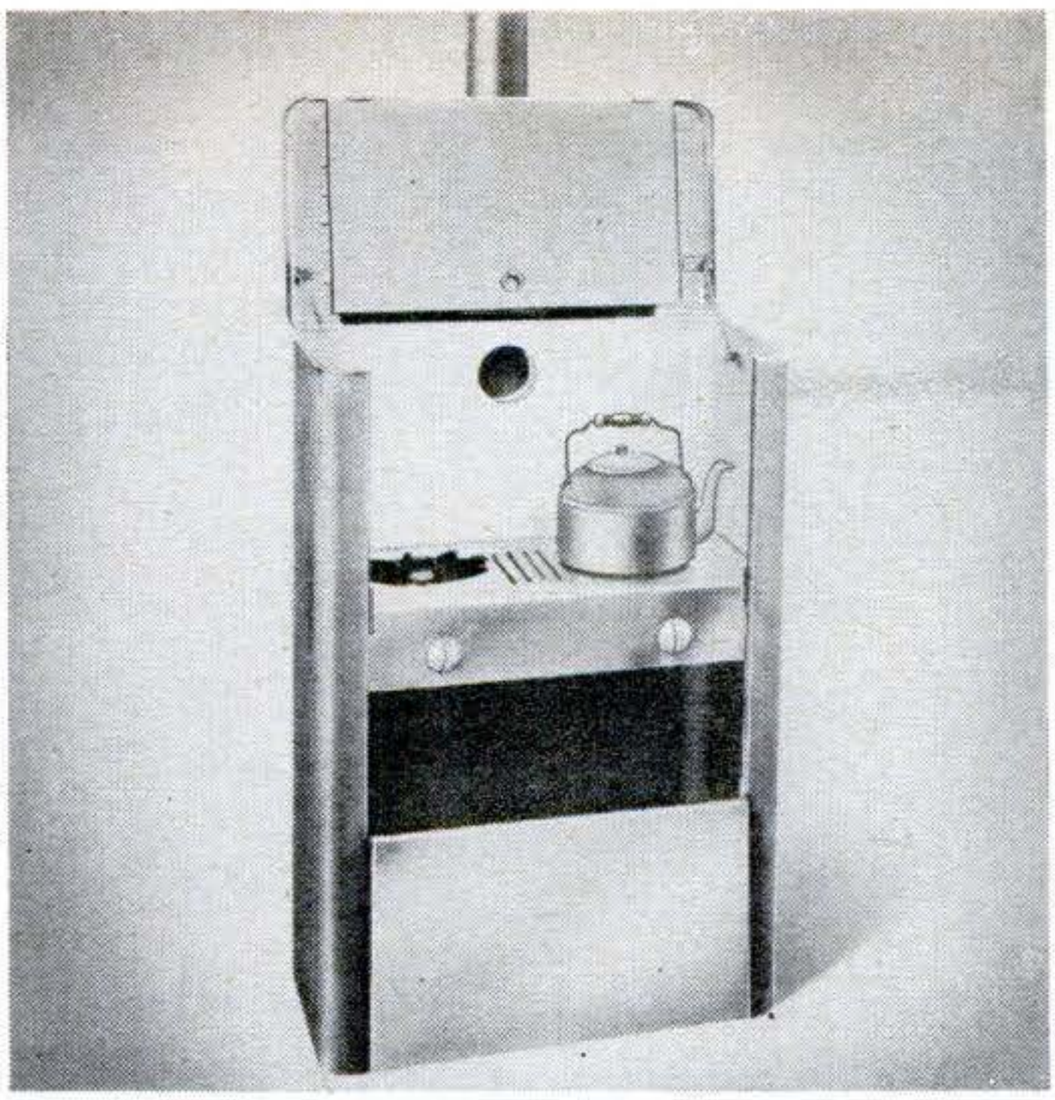
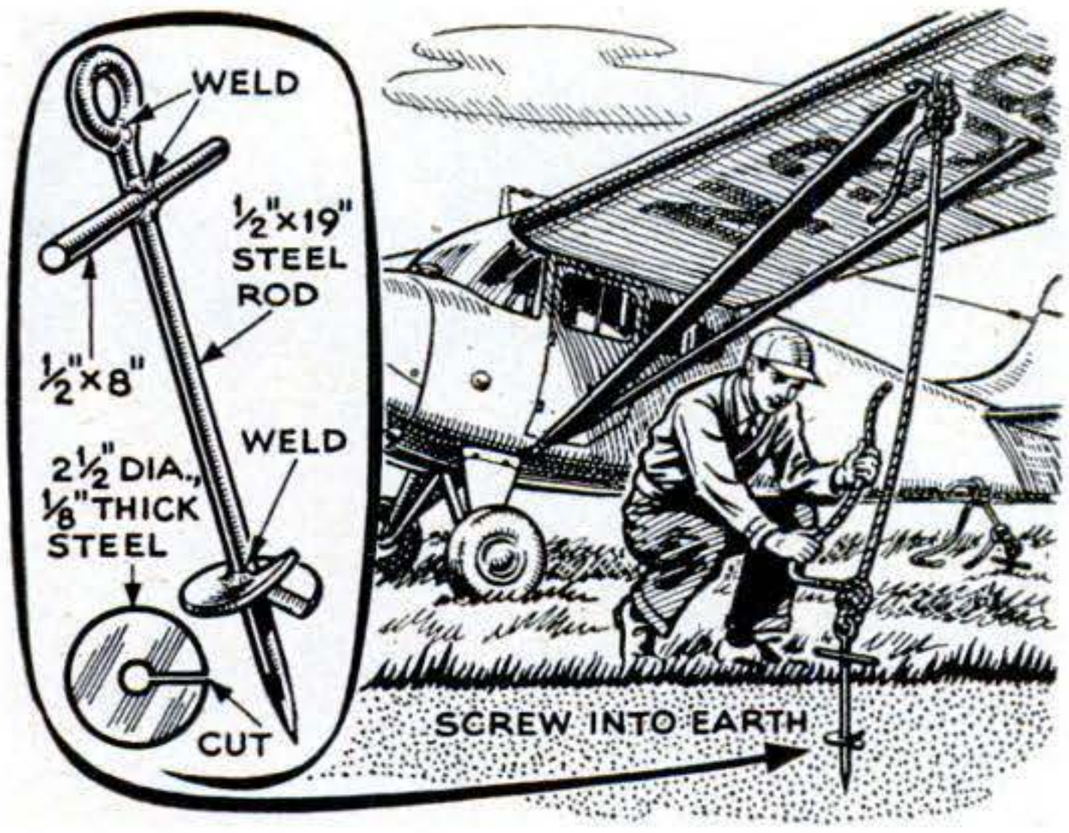


Heater Is Also Cooking Stove

IF YOU live in one or two rooms, here's a compact solution to your heating and cooking problems. With the lid and front closed, this oil burner delivers heat through a register on top. When you want to prepare food, it can be adjusted for use either as an oven or hot plate. Made of heavy gauge aluminum, it's a product of the Lynbrook Company, of Muskogee, Okla.

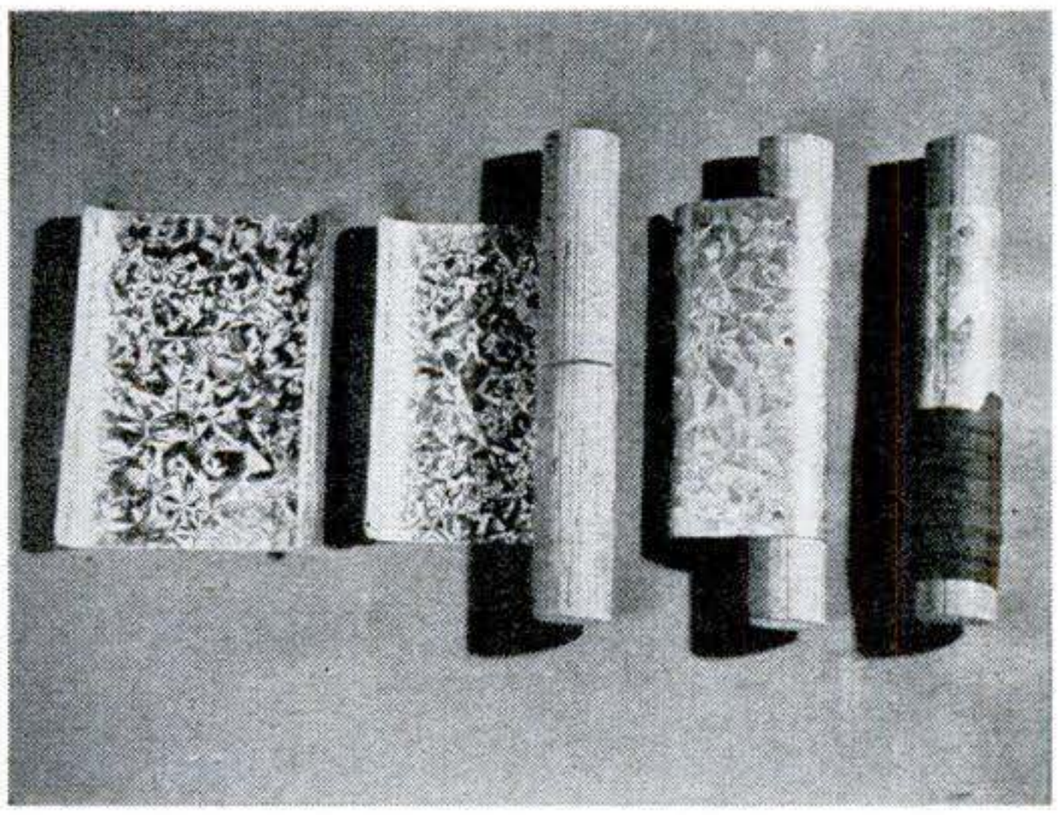
Sheet Plastic Covers Kite

KITES now have plastic wings. A bird-shaped kite just introduced by the Multiple-Socket Fixture Co., of Cleveland, has aluminum tubing for horizontal spars and a framework that is covered with colored sheet plastic. Priced at $2, it comes knocked down, but is easily prepared for flight. While not in use, it can be taken apart and tucked into a storage tube.



Screw Anchors Keep Plane Safe

THREE homemade anchors like this will help hold down a plane during a hard blow. Turned into the ground screw-fashion, the anchors give better protection than straight stakes. The 8″ crossbar ordinarily provides enough leverage for turning the anchor into the ground. Three of these anchors and three lengths of ⅝″ or ¾″ rope can be easily carried in the luggage compartment of a light plane.—*Paul W. Crutcher, Modesto, Calif.*



Metal Wrap Repairs Handles

HERE'S how I often repair round wood handles or poles when they're broken. Square stock could be treated in the same way. The repair is surprisingly strong.

First cut a rectangle of sheet iron and round up the edges as at left. Next nail the metal across the joint, placing nails along one edge. Continue nailing as you wrap the metal around the wood. A final wrapping with friction tape will protect your hands.—*W. J. Spangler, San Francisco.*

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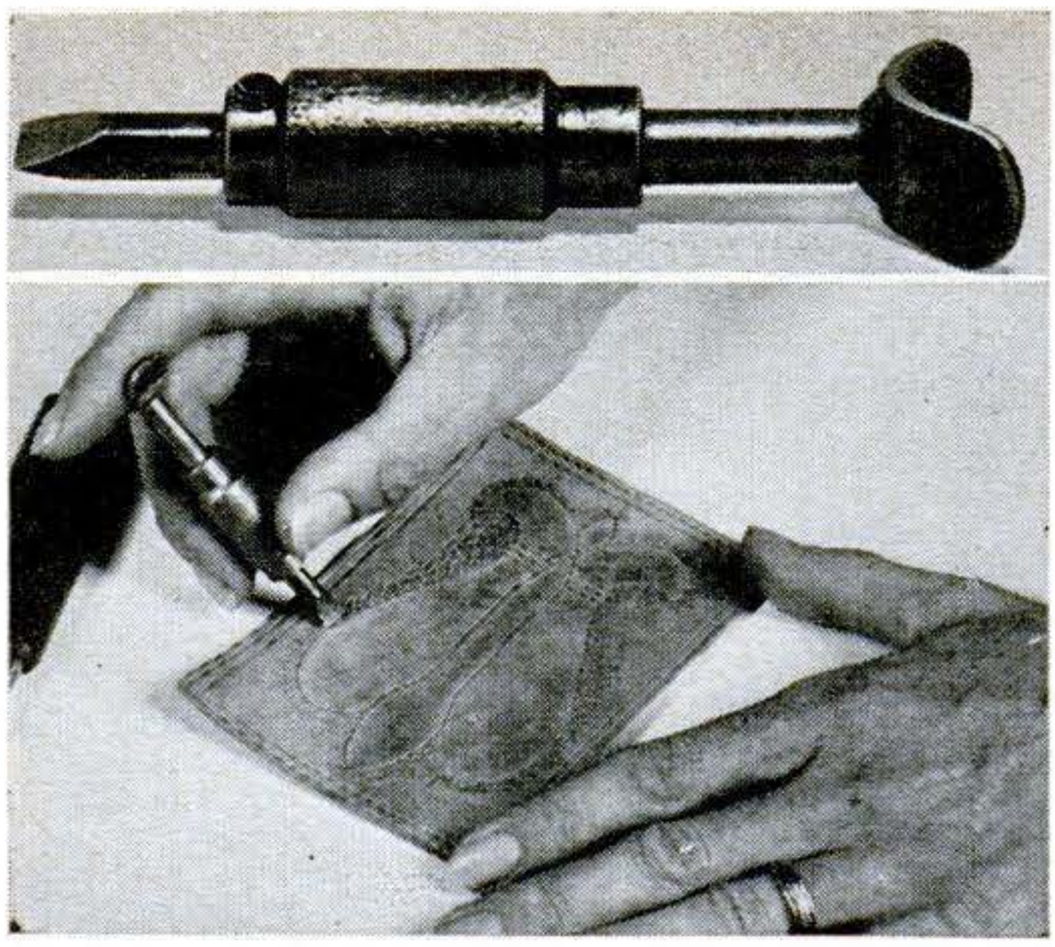
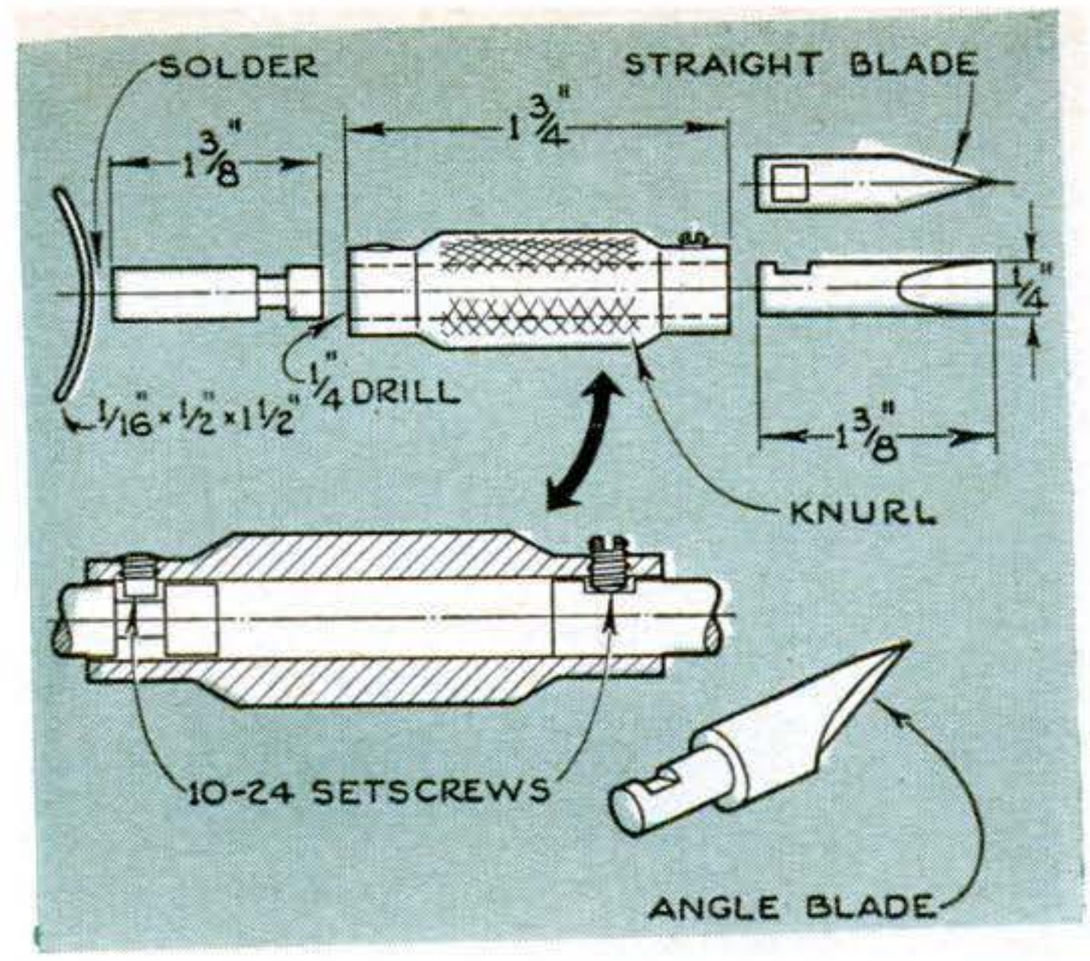


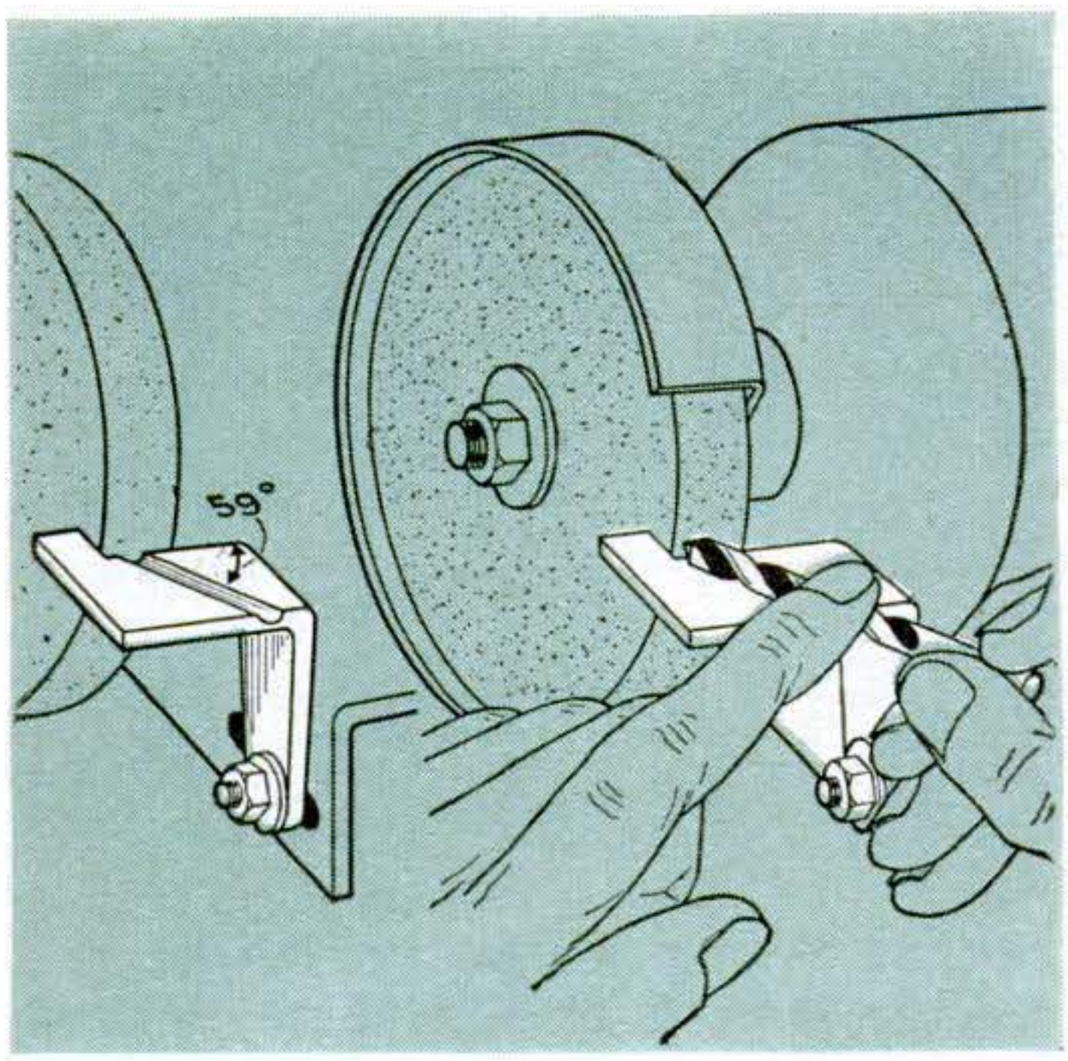


Swivel Knife Cuts Curved Lines in Thin Material

ACCURATE cuts along curved lines are possible with this knife, which is a natural for leather work or stencil cutting. The blade turns with the knurled handle, while the finger rest guides it and applies pressure.

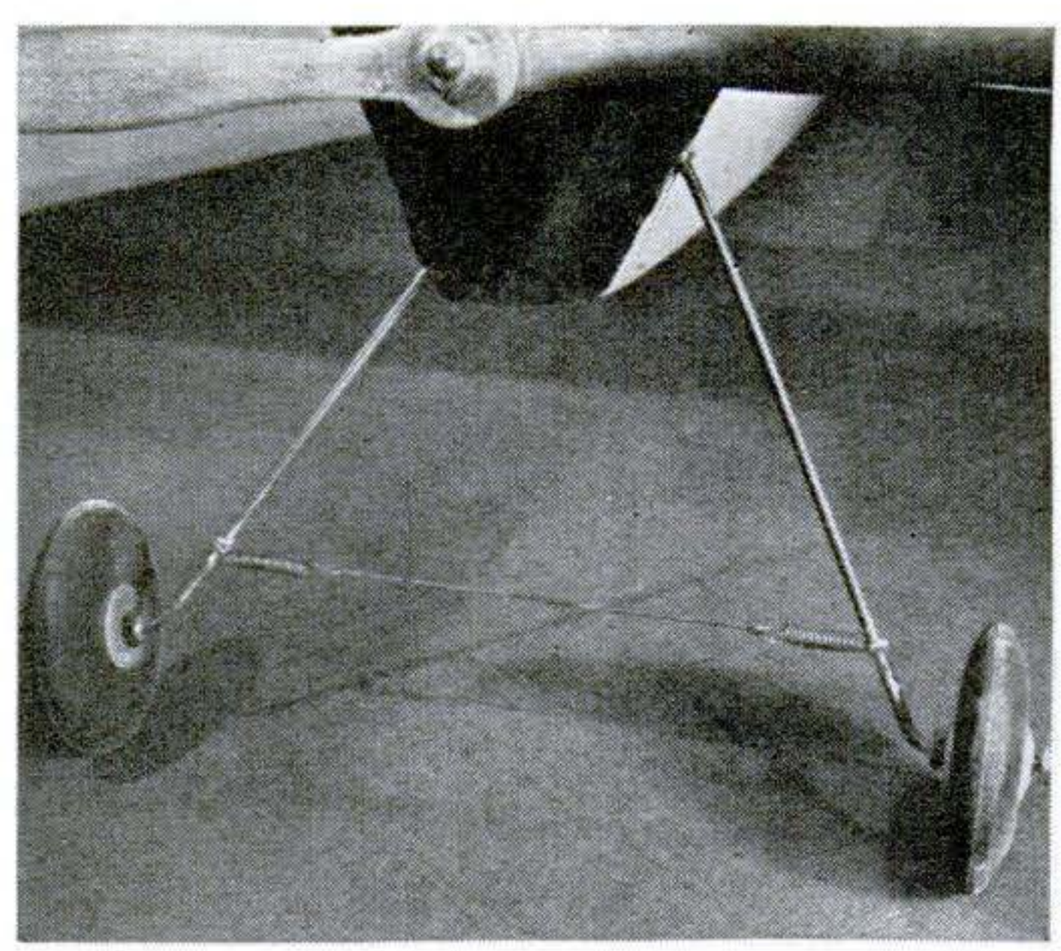
The original was made from scrap brass and drill rod. Use good steel for the blades so they'll hold an edge. A lathe helps in making the knife, but the job can be done by hand. Solder the curved finger rest to the upper end of the shank. Turn or file a groove in the lower end of this piece to receive the upper setscrew. File the head of this screw flush and solder it after making sure the handle turns freely.

Blades of many shapes and sizes can be made. Two types are suggested in the drawing. Grind to shape, harden and temper, and stone lightly. Make a flat for the screw on the shank.—*J. T. Fountain, Lubbock, Texas.*



Groove Aids Drill Grinding

A DRILL-GRINDING guide can be made by filing a round groove in the grinder tool rest at a 59-deg. angle. Hold the drill in the groove with one finger and rotate it while grinding. This will give the correct angle and make the cutter lips of equal length. Cutter clearance can be ground freehand. —*H. E. Graves, Huntington Park, Calif.*



Landing Gear Absorbs Shock

HERE'S a landing gear that reduces the chances of damage to a model airplane by absorbing part of the landing shock. Two small springs and a length of flexible piano wire are used as the cross brace instead of the usual stiff piano wire. This arrangement allows the landing gear to spread slightly when the model hits, and then brings it back to its original position.—*Paul Hertzberg, Jackson Heights, N. Y.*

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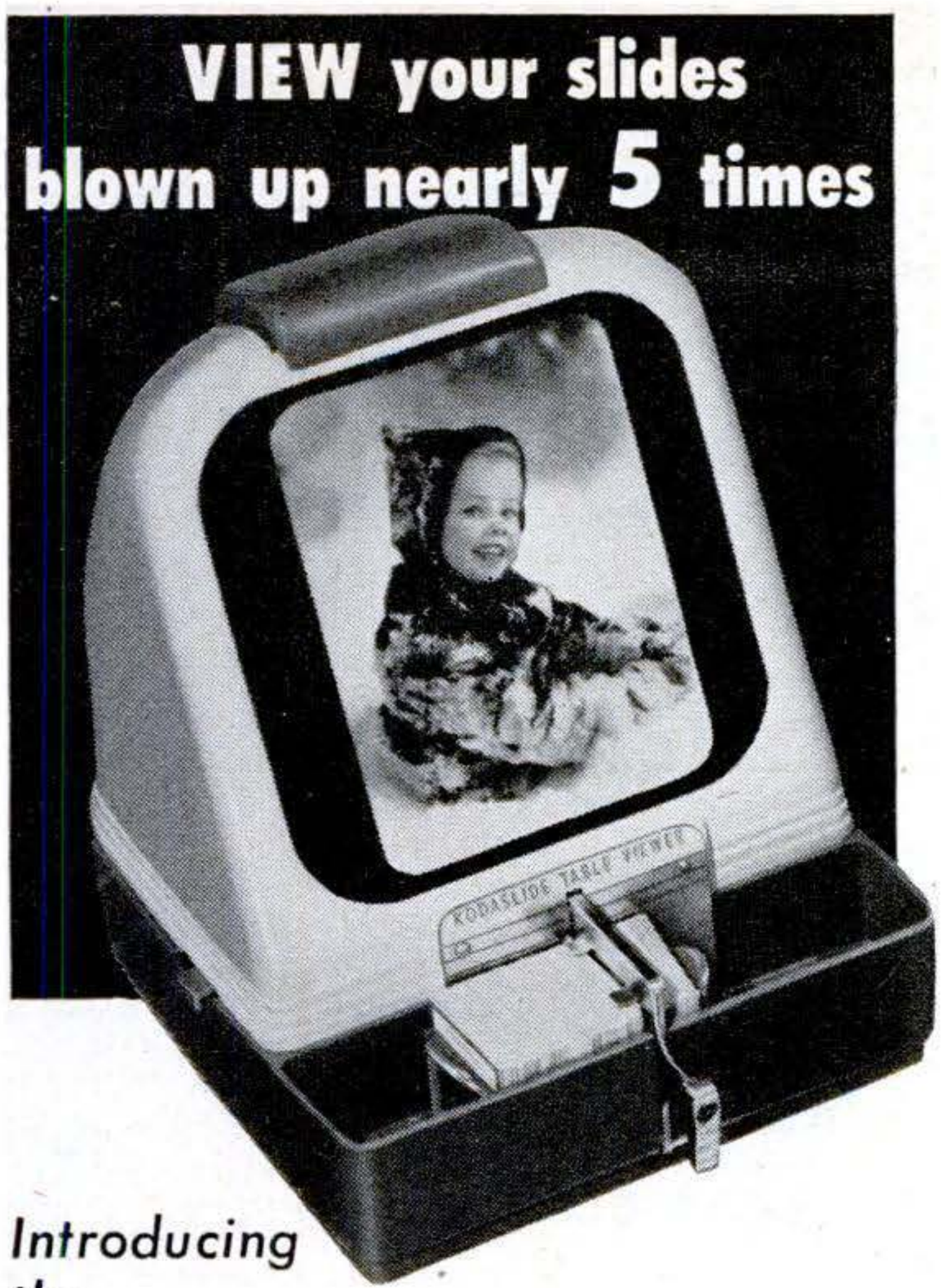

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Good news for 35mm. and Bantam slide fans: For quick shows with 2 x 2-inch slides, small-group viewing, initial review and editing, it's the new Kodaslide Table Viewer. Ask your Kodak dealer for a demonstration and see for yourself. Price, $95.

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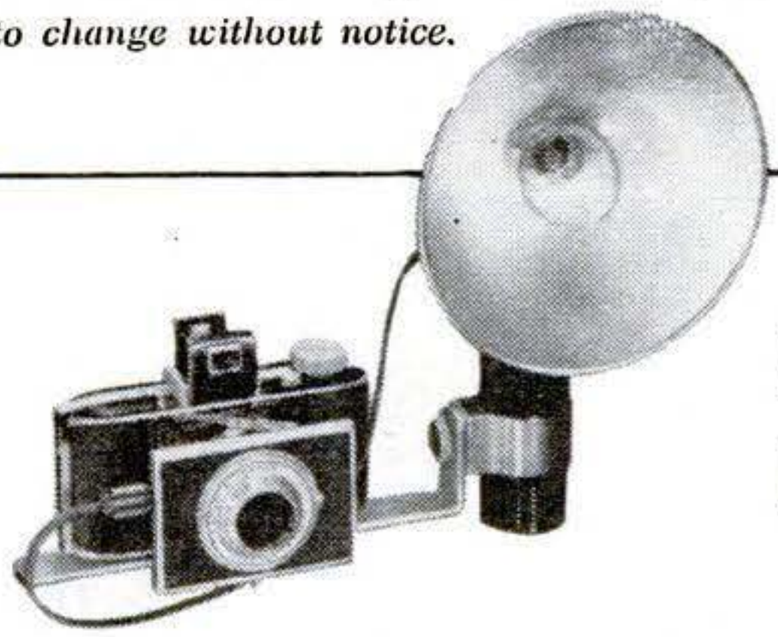
Efficient cooling system (by convection) protects slides in Viewer.

The body is of die-cast aluminum, finished in buff and brown. Viewer uses AC or DC current; has eight-foot cord.



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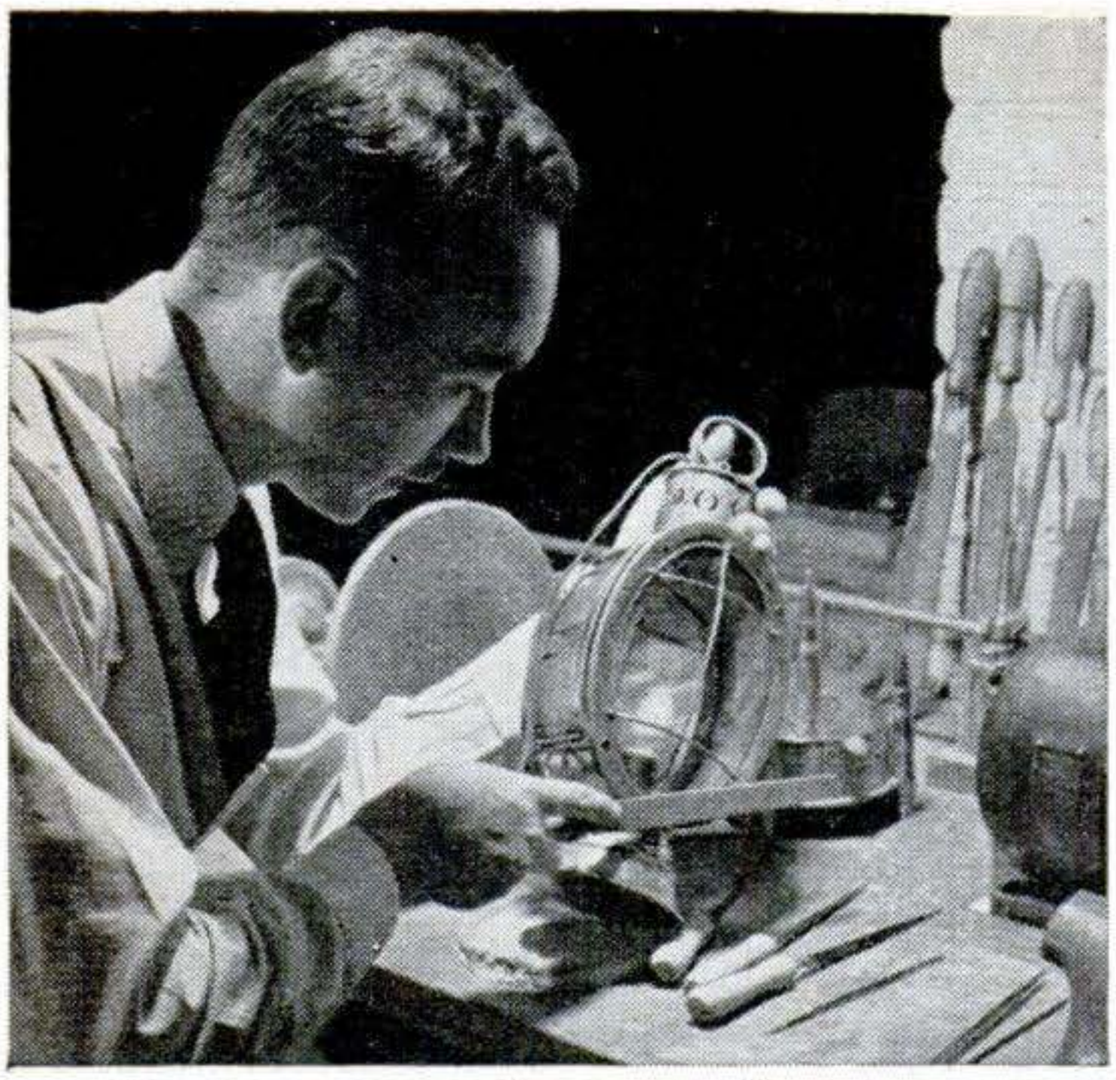

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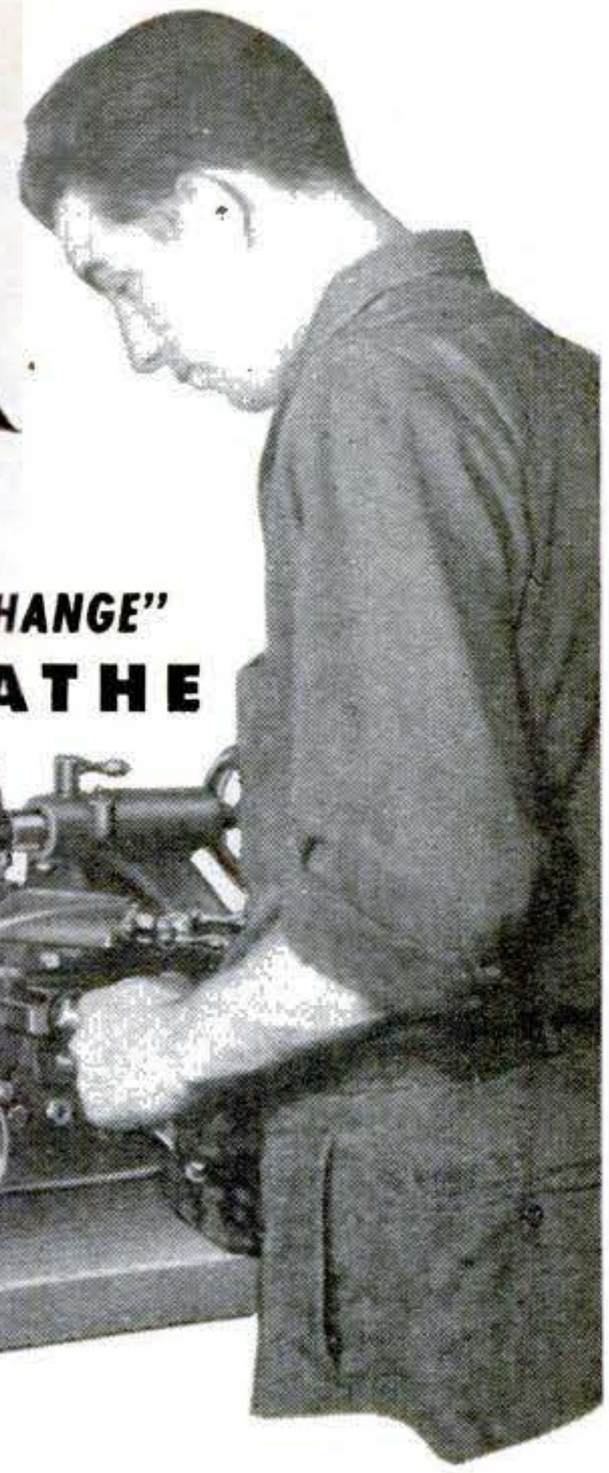

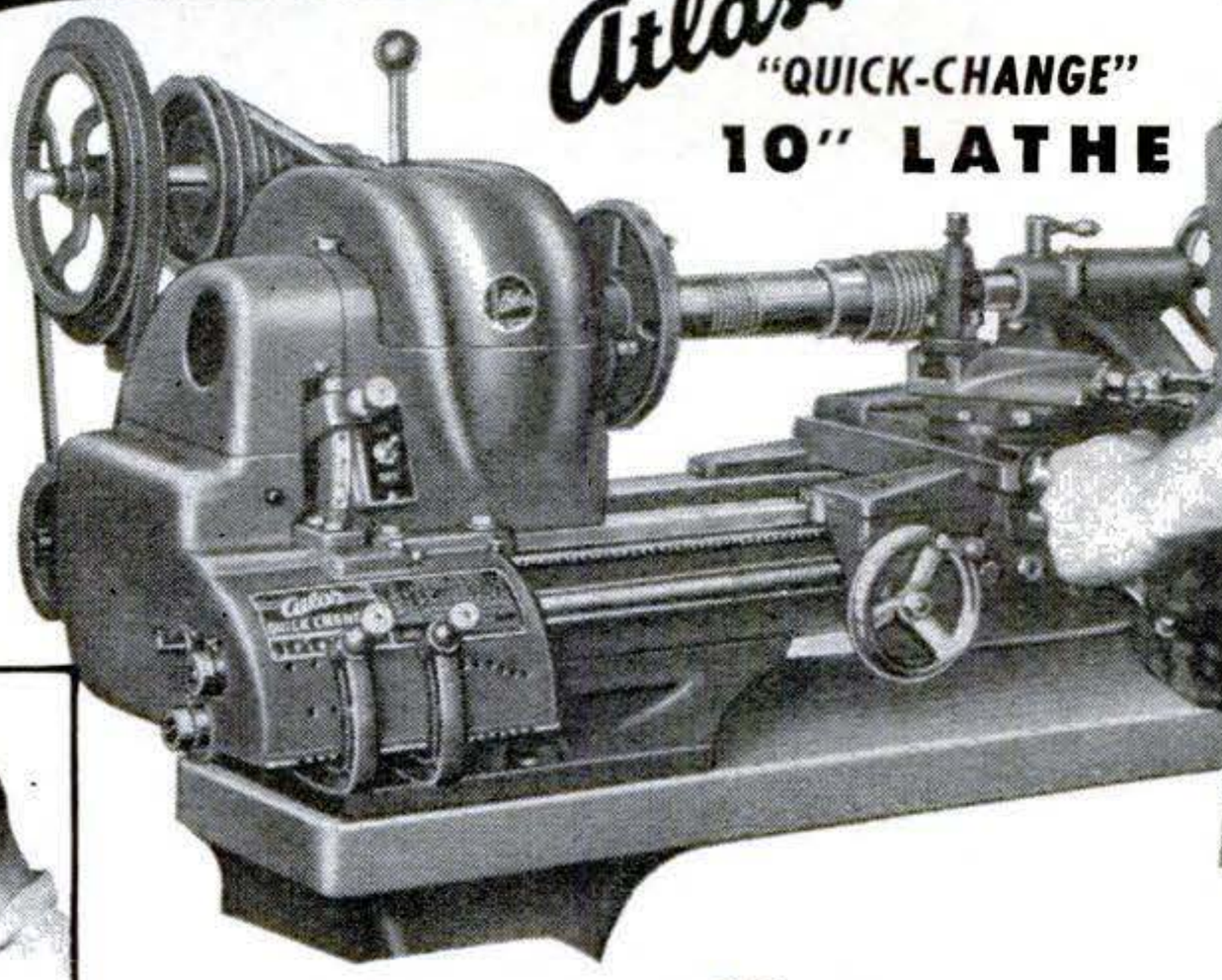

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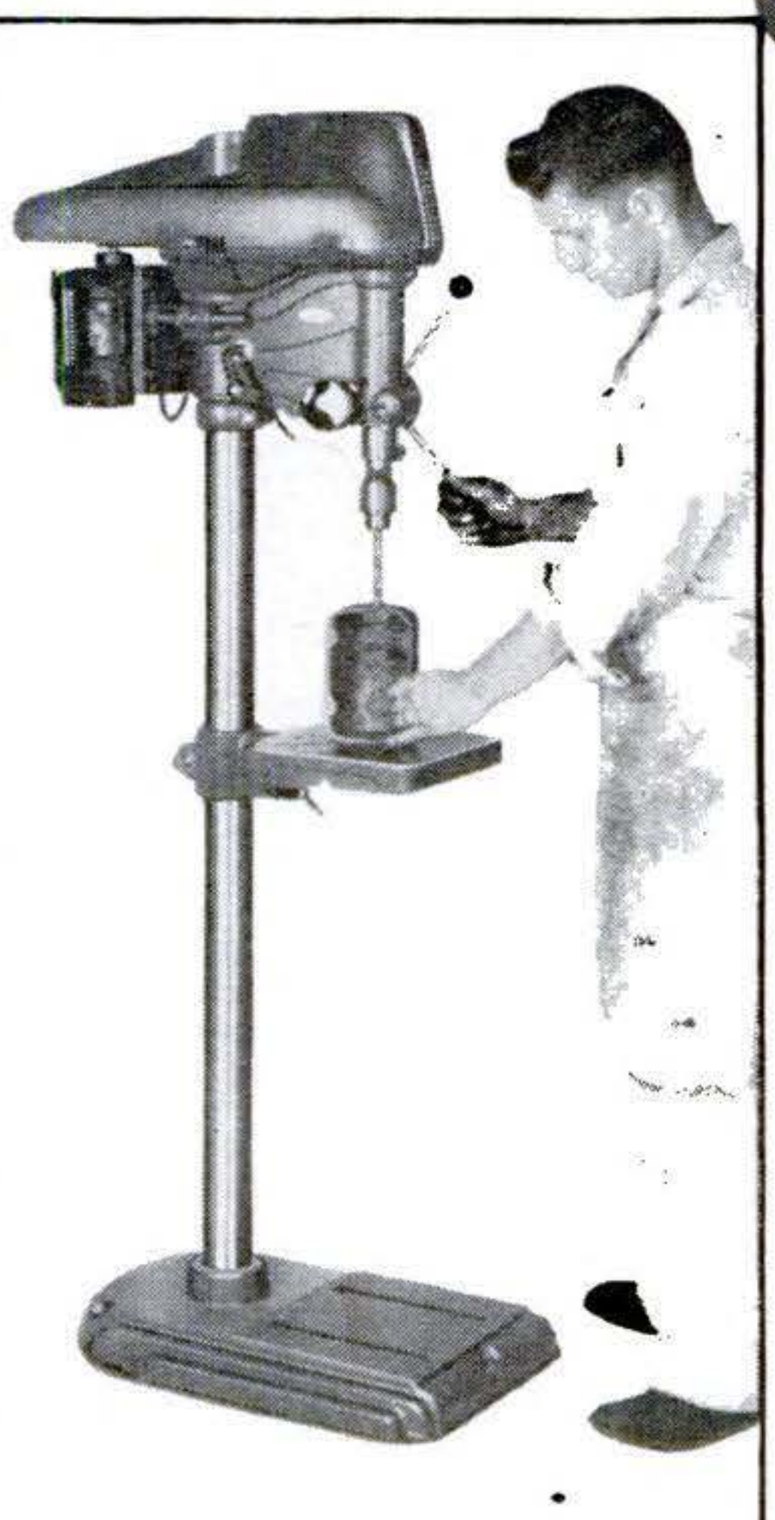

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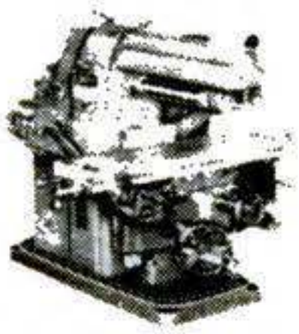

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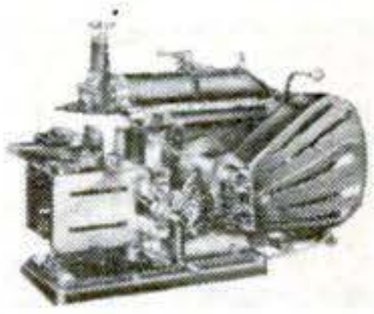

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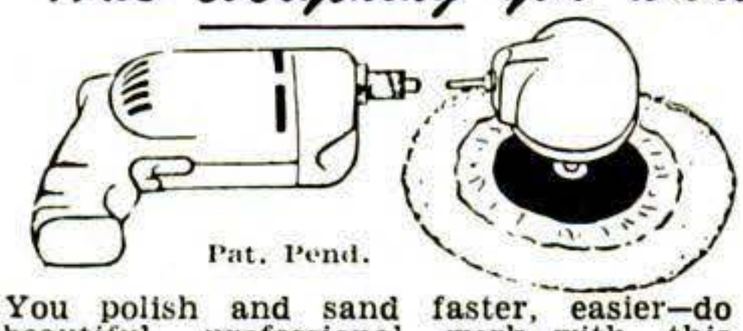

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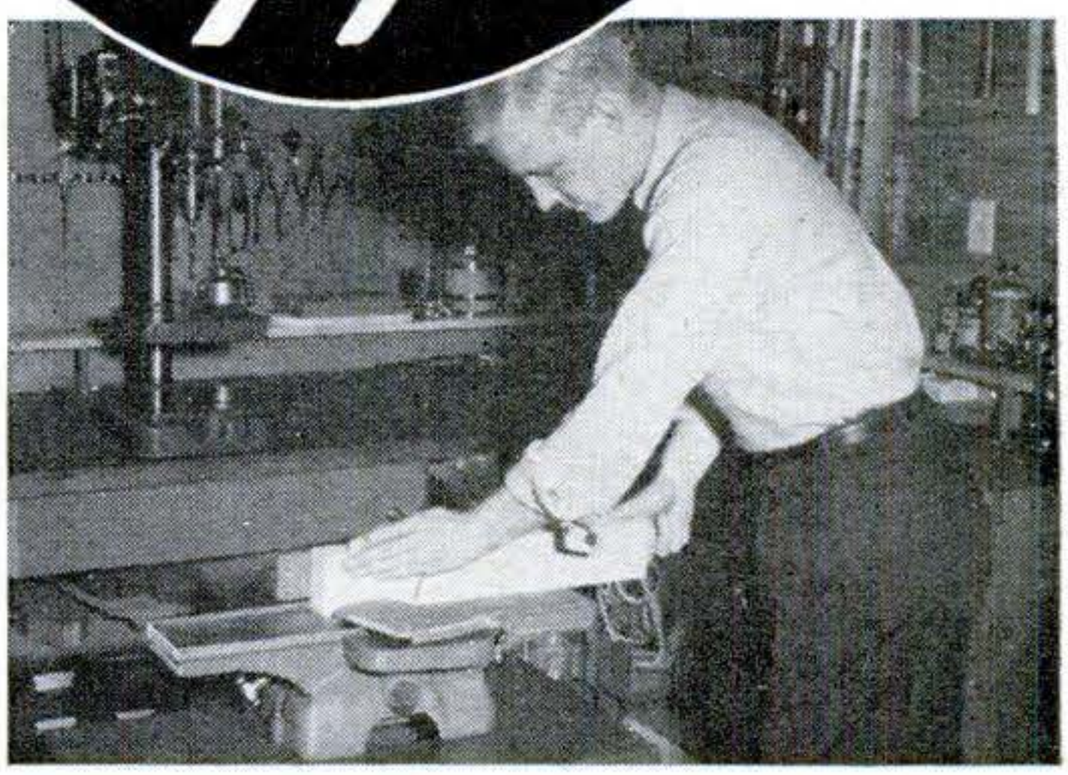

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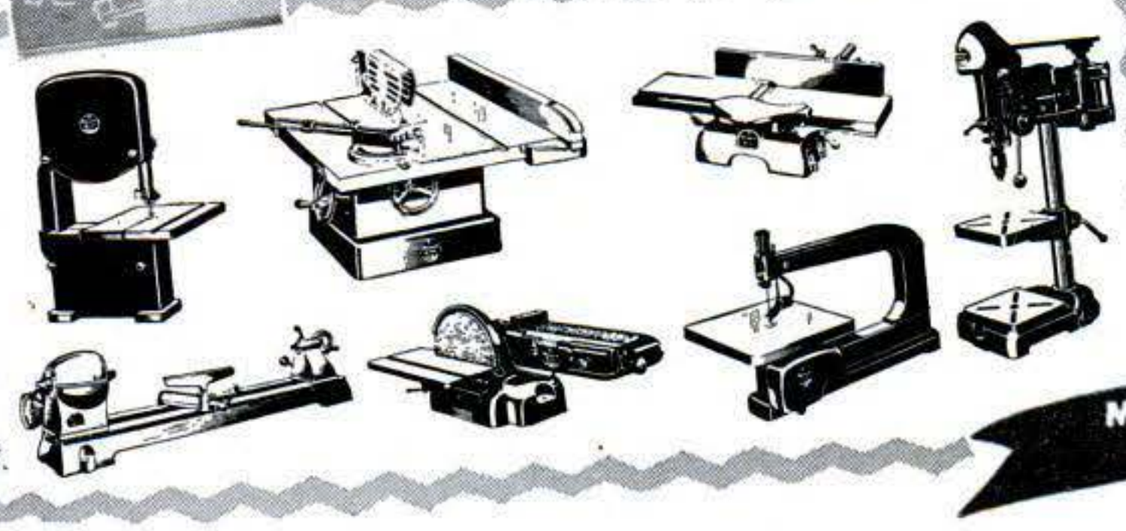

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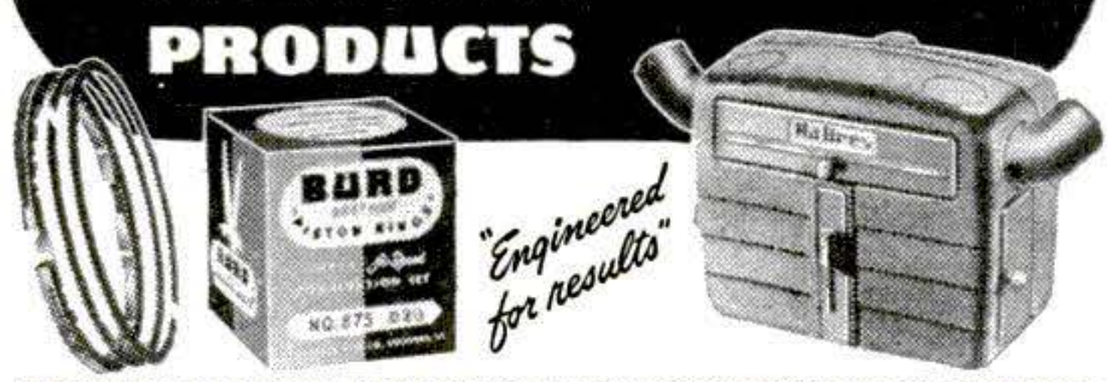

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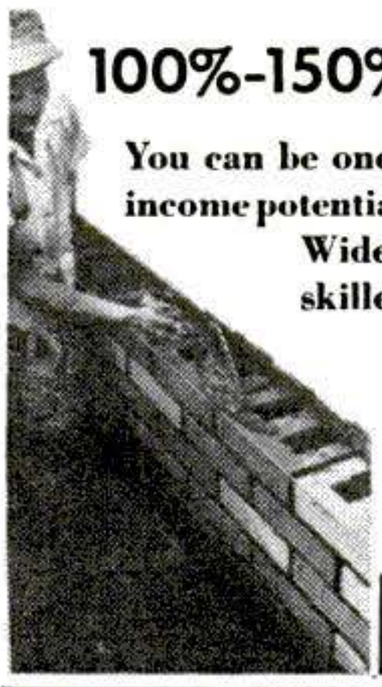

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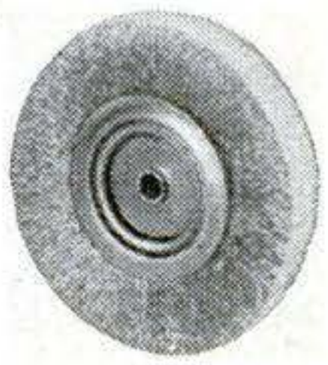

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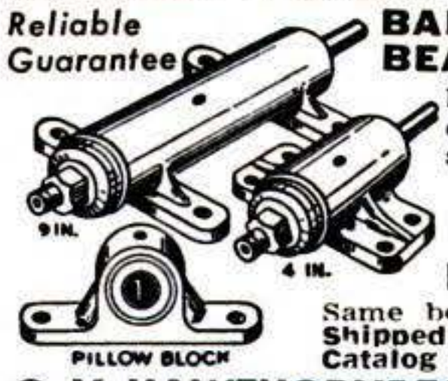

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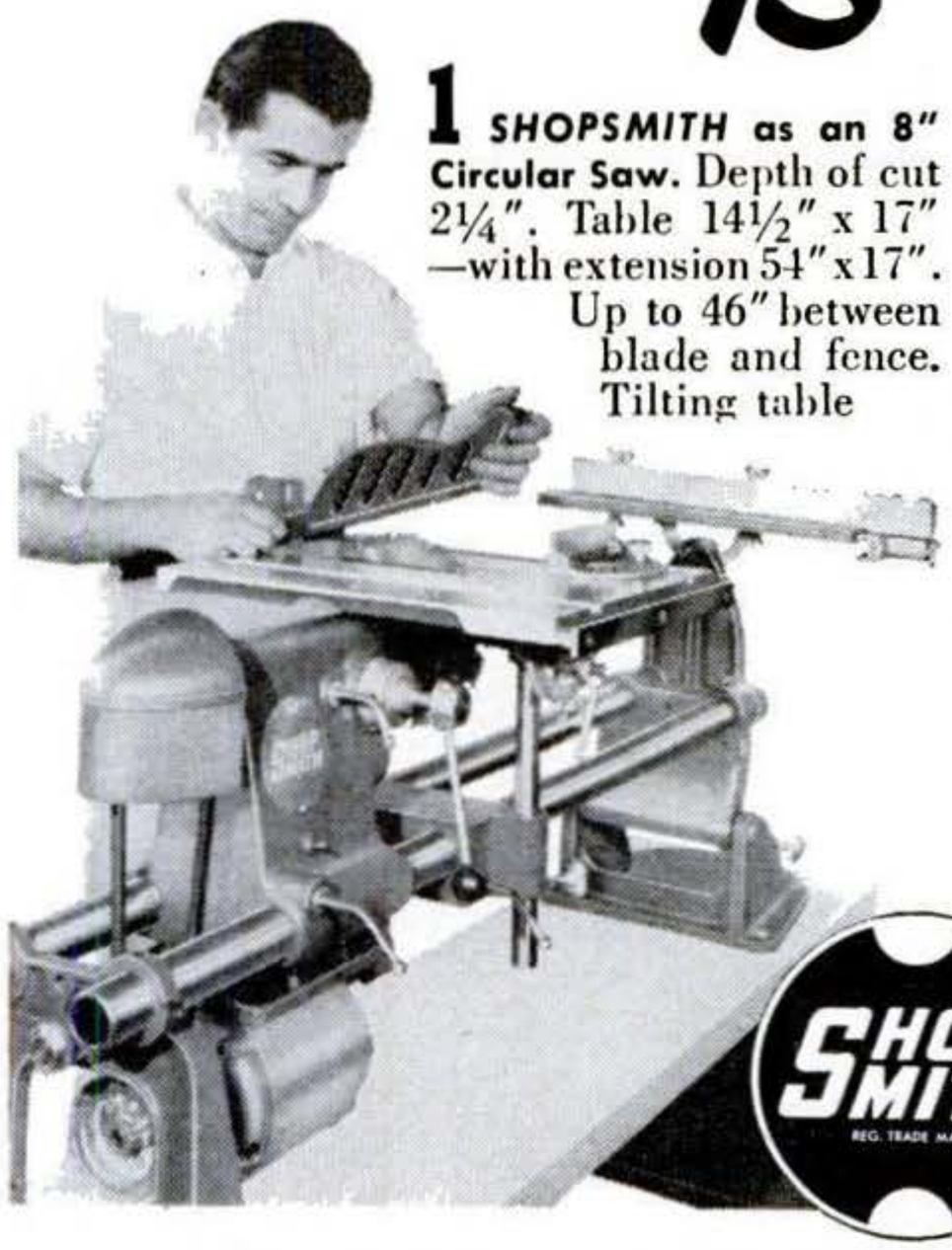

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$159.50
with ½ h.p. ball bearing motor
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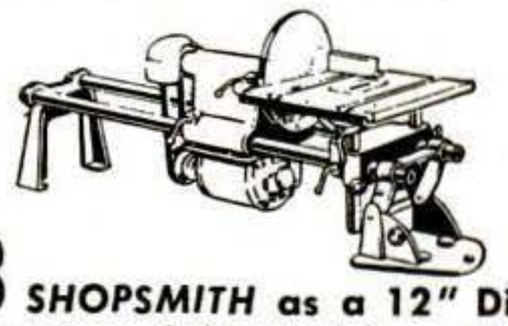
2 SHOPSMITH as a Vertical Drill Press. Drills to center of 15-inch circle. 27-inch maximum distance from table to chuck, 4¼-inch feed



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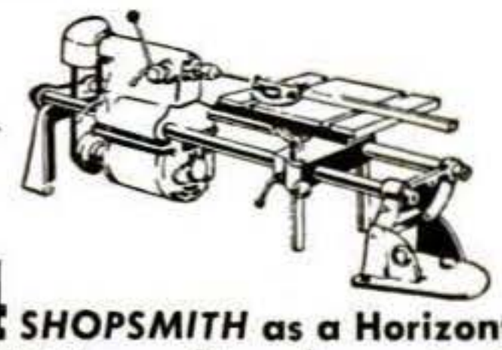

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5 SHOPSMITH as a 34" Wood Lathe. (34" between centers) with a 15-inch swing. Quill feed 4¼ inches. Tool rest always slides parallel to ways

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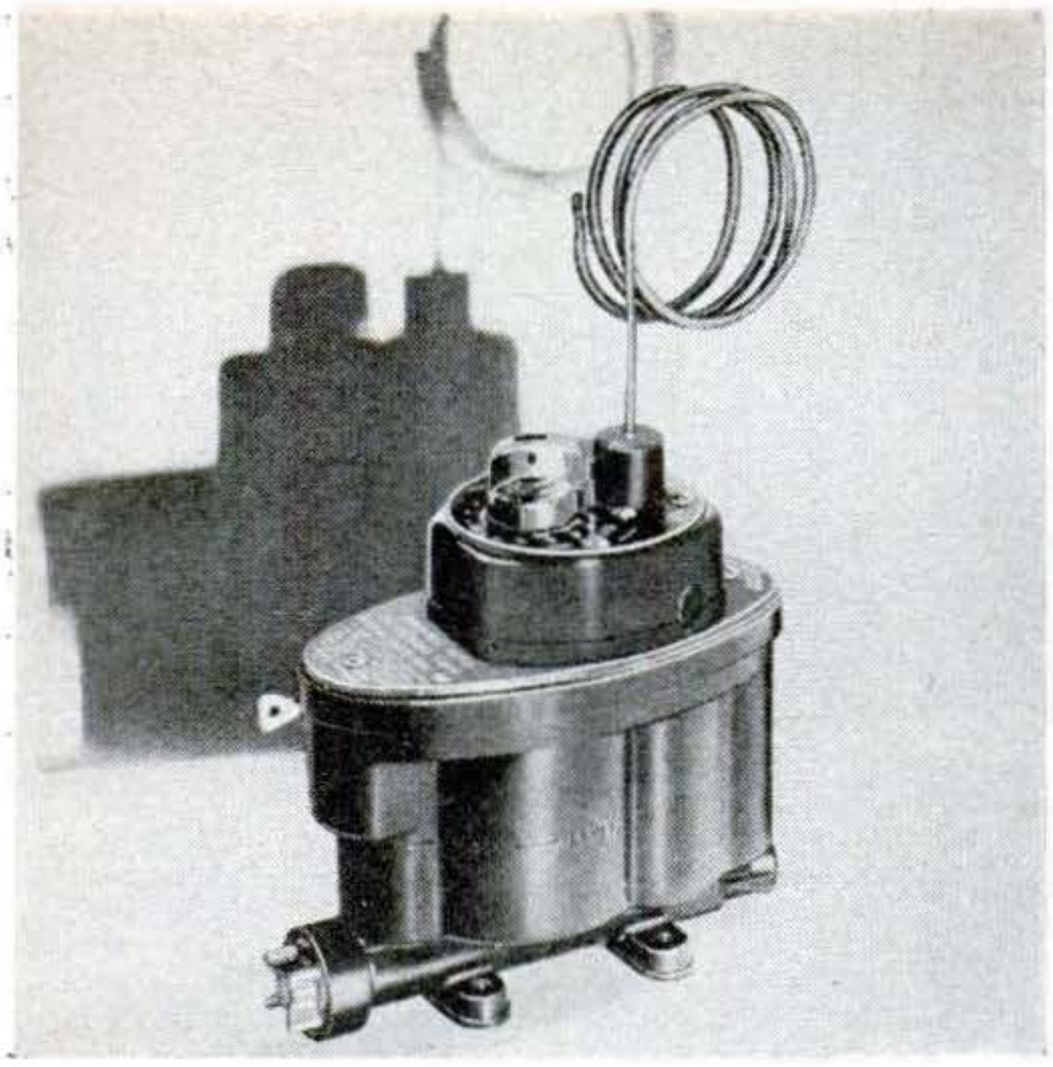

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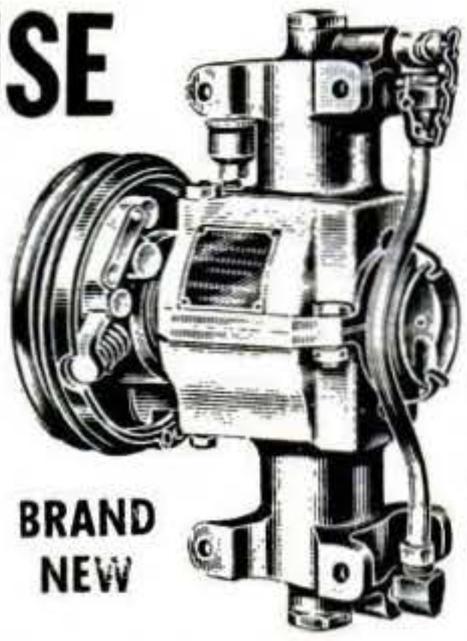

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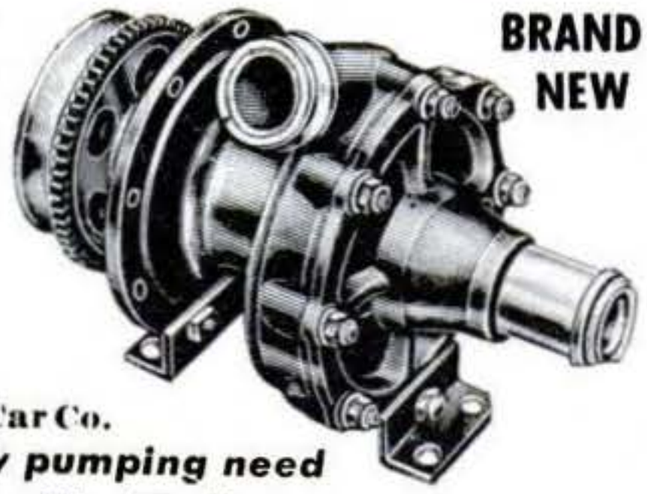

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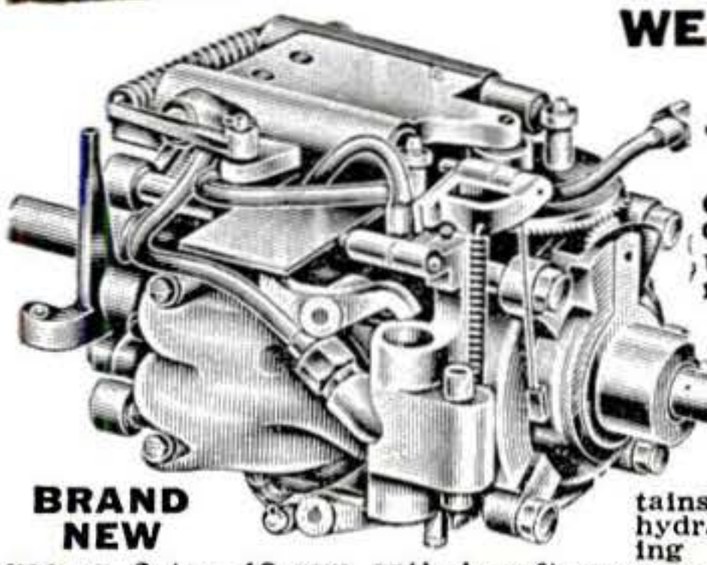

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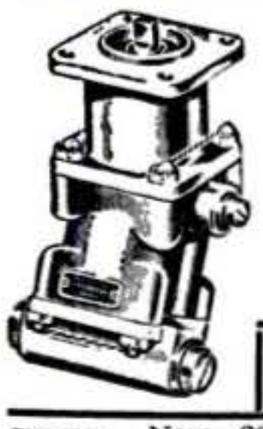

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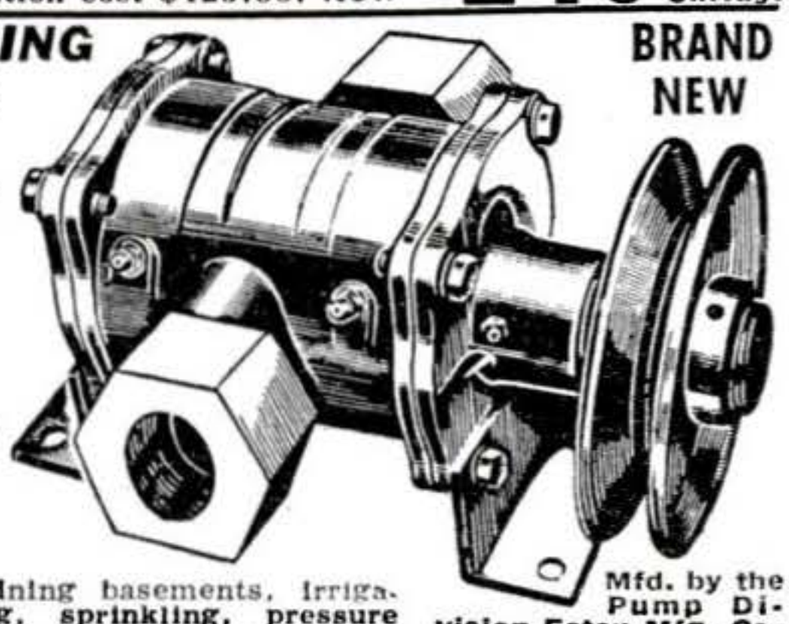

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● **Use hydraulics on arbor presses, hydraulic presses, hay lifts, manure loaders, lift trucks—push or pull, tilt or turn, press or squeeze, open or close, lift or lower—and other hydraulic and industrial applications. Use with either air or oil . . . of finest precision workmanship.**

1 **Double action, 1½" bore, 5" stroke,** will lift 1760 lbs. in one second with Vickers MF9 Pump. Wt. 3 lbs. A $35.00 value..... **$8.95** post-paid

2 **Double action, 1½" bore, 9" stroke,** will lift 1760 lbs. in one second with Vickers MF9 Pump. Wt. 4 lbs., A $45.00 value..... **$10.95** post-paid

3 **Use these cylinders on farm trucks,** bulldozers, hay lifts, manure loaders, etc. Double action, 1½" bore, 27" stroke. (Will lift 1760 lbs. in 2 seconds with Vickers Pump.) Wt. 8 lbs. A $55.00 hydraulic cylinder value for only..... **$12.95** post-paid

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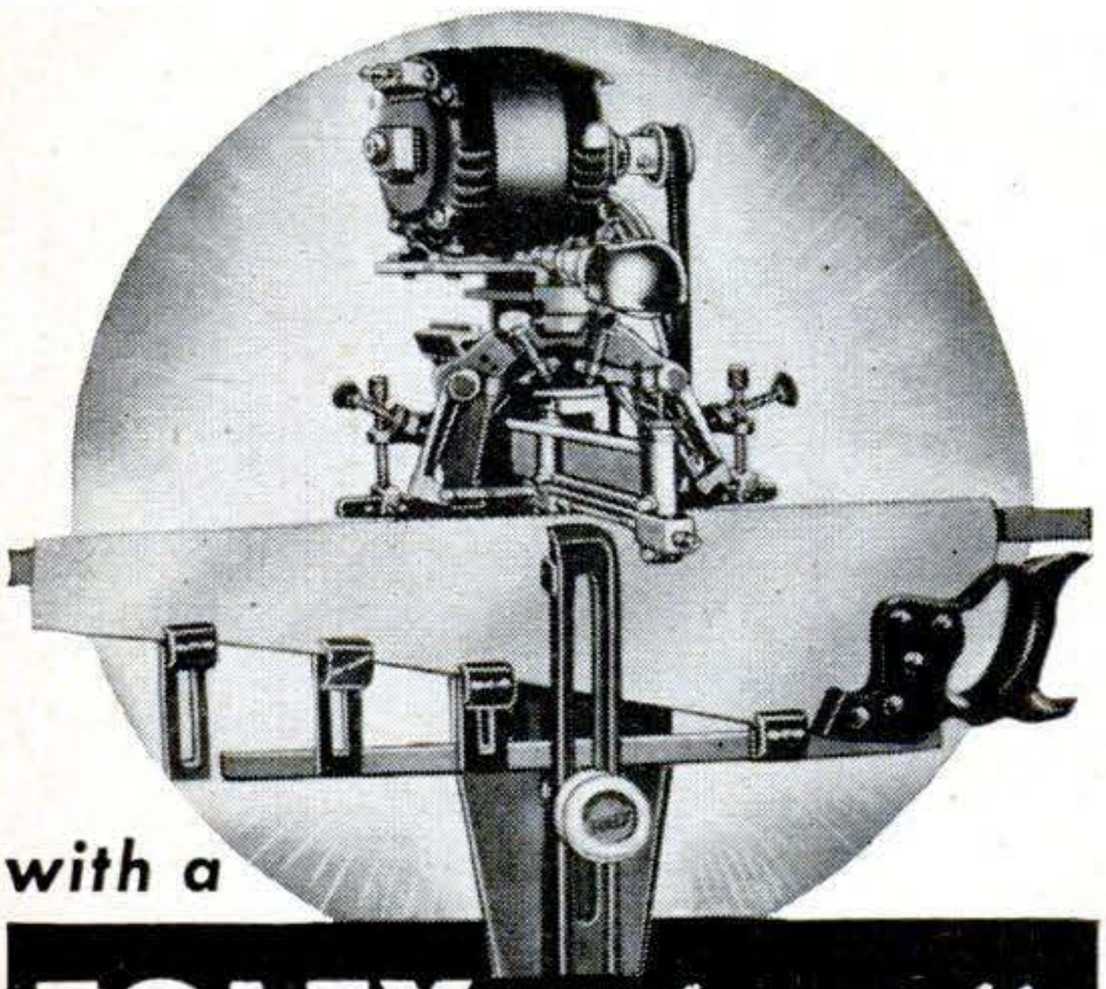

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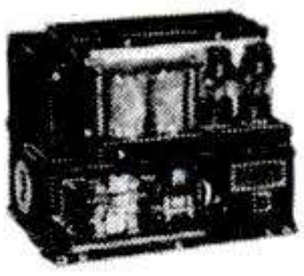

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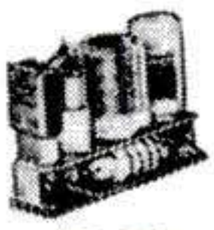

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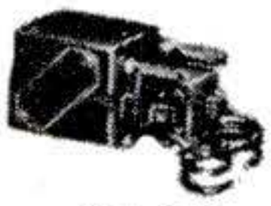

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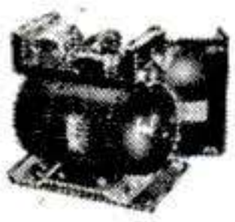

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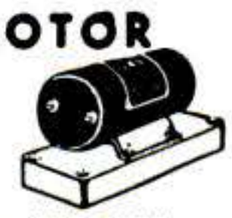

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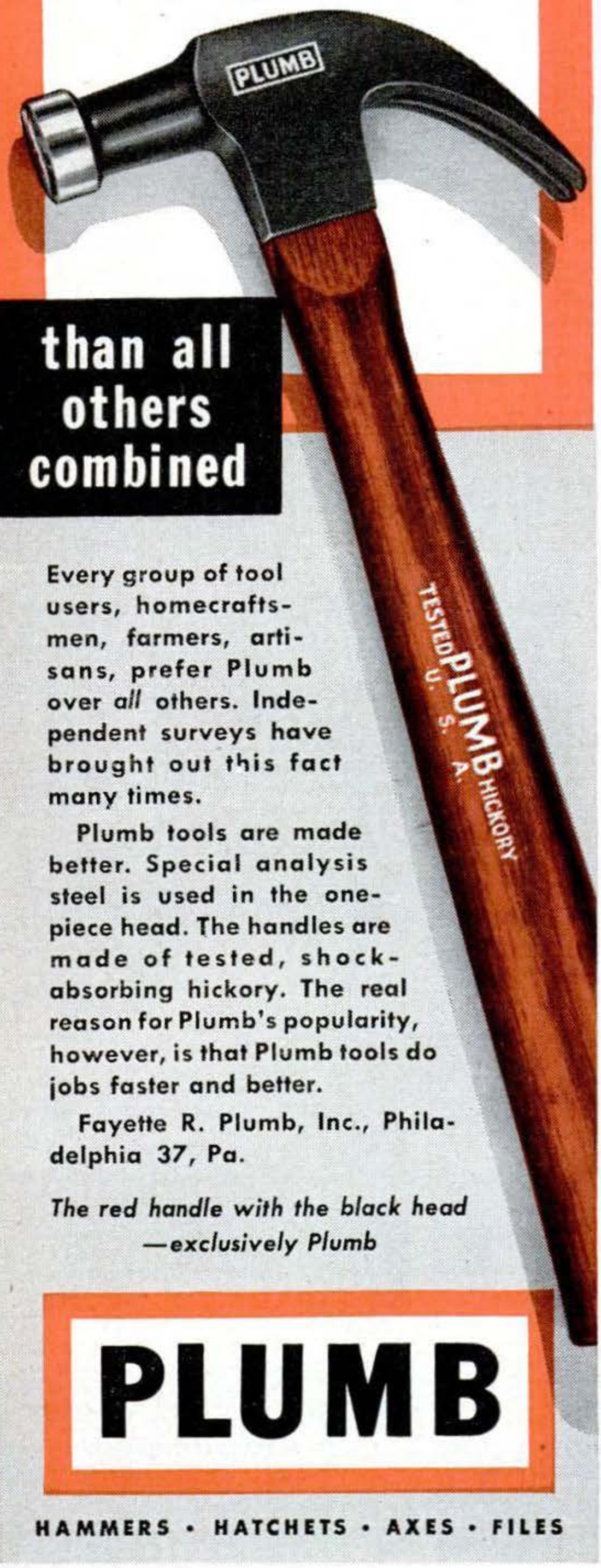

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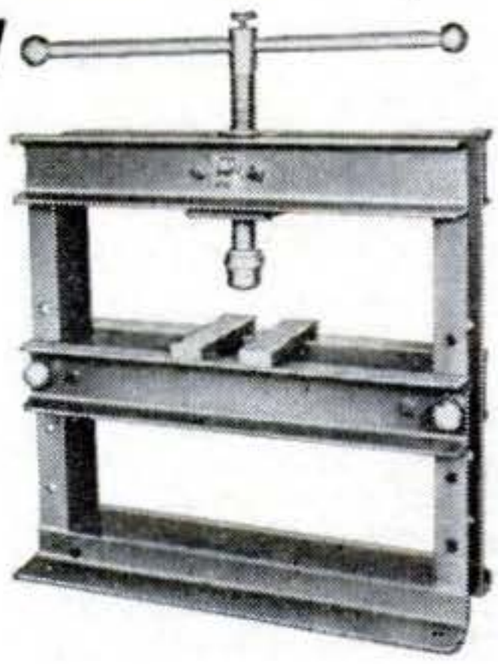

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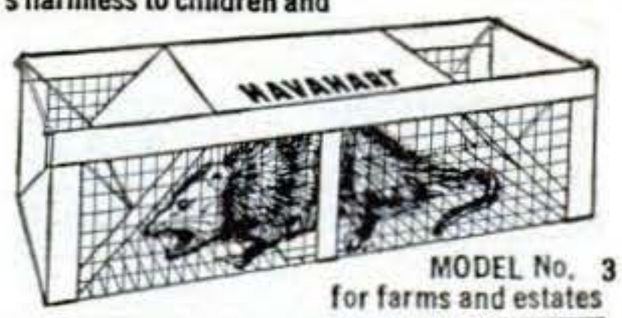

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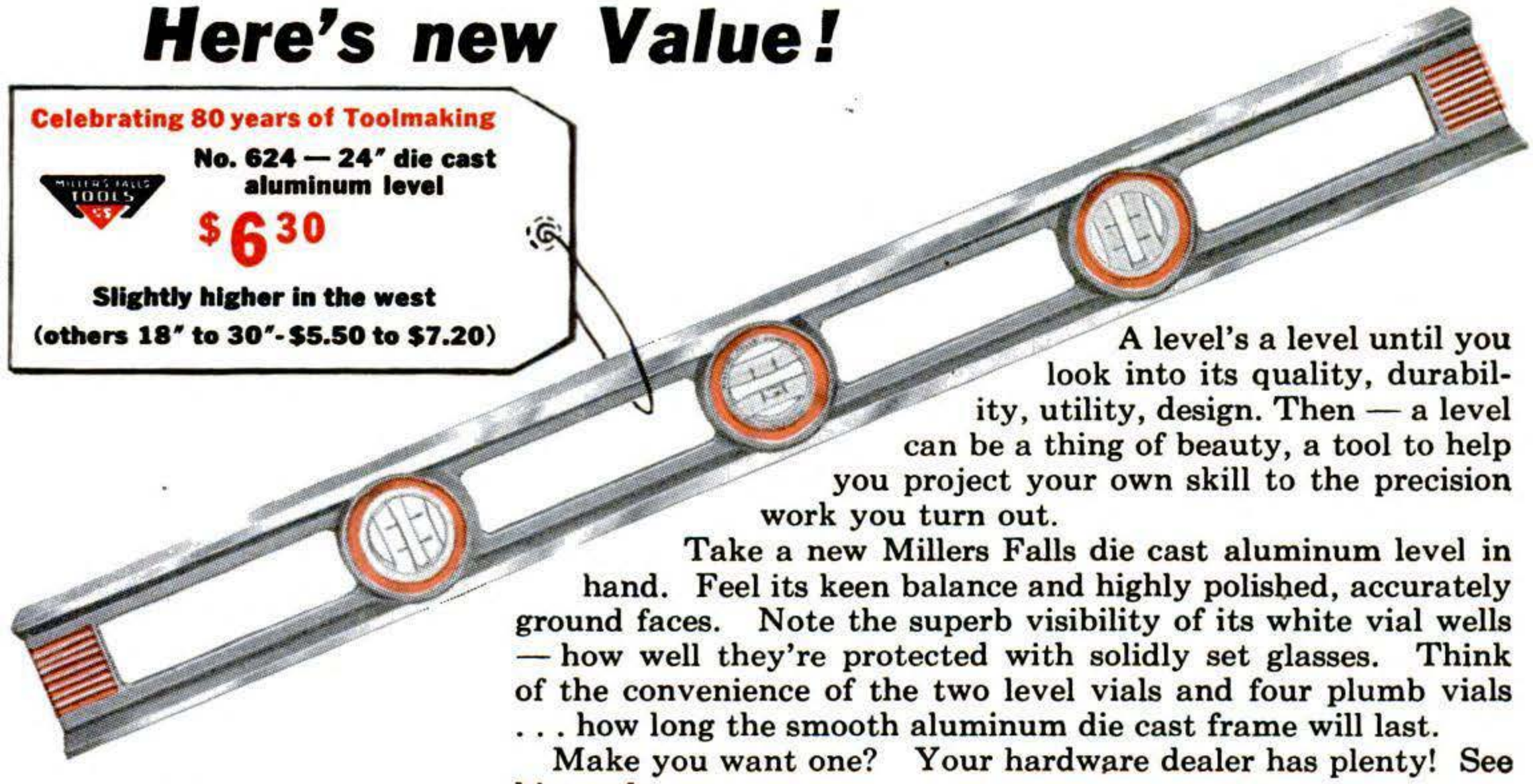

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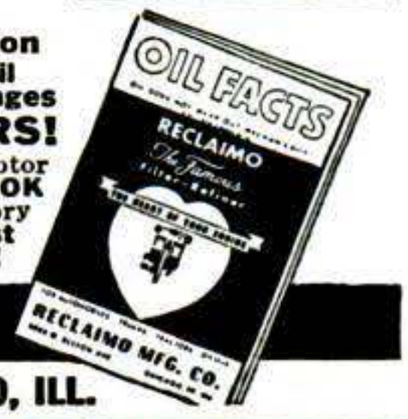

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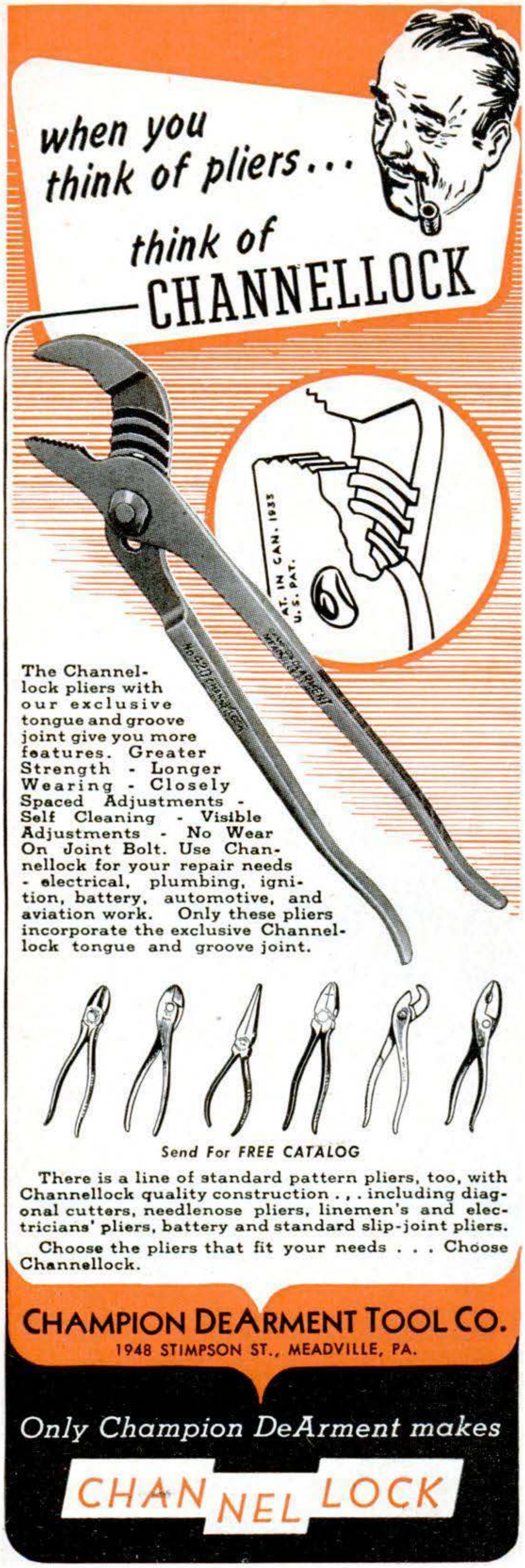

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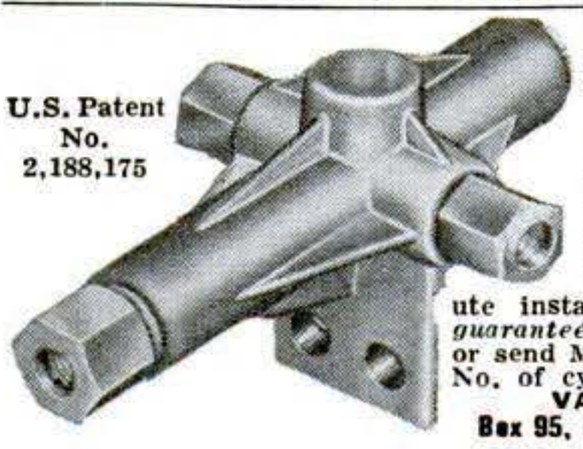

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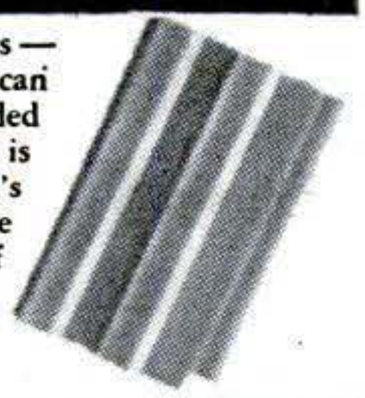

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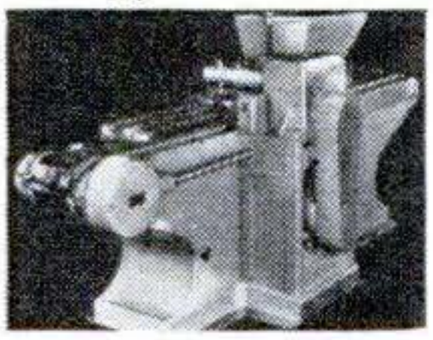

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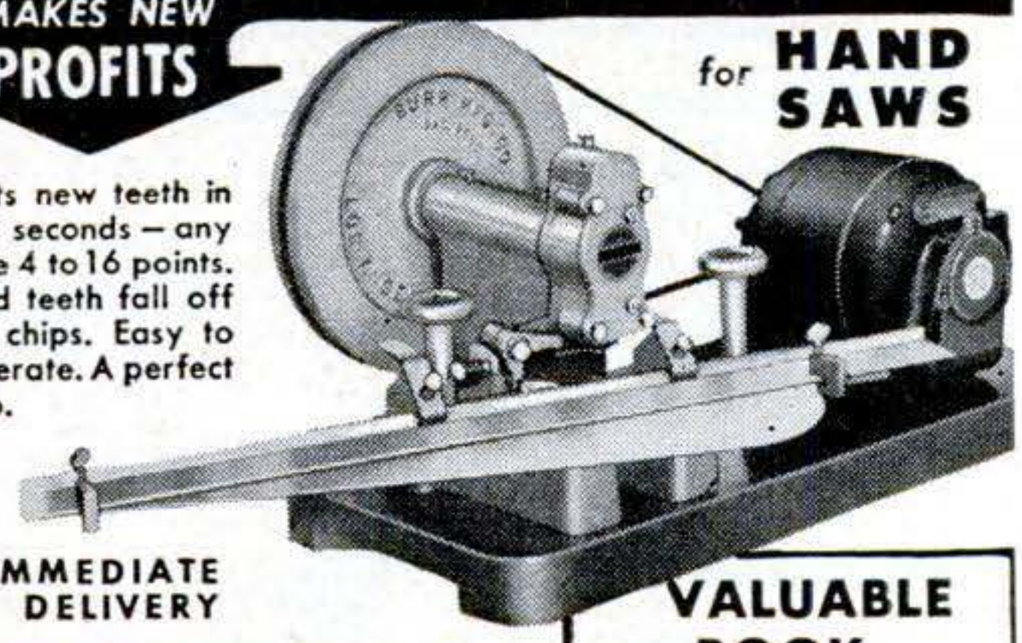

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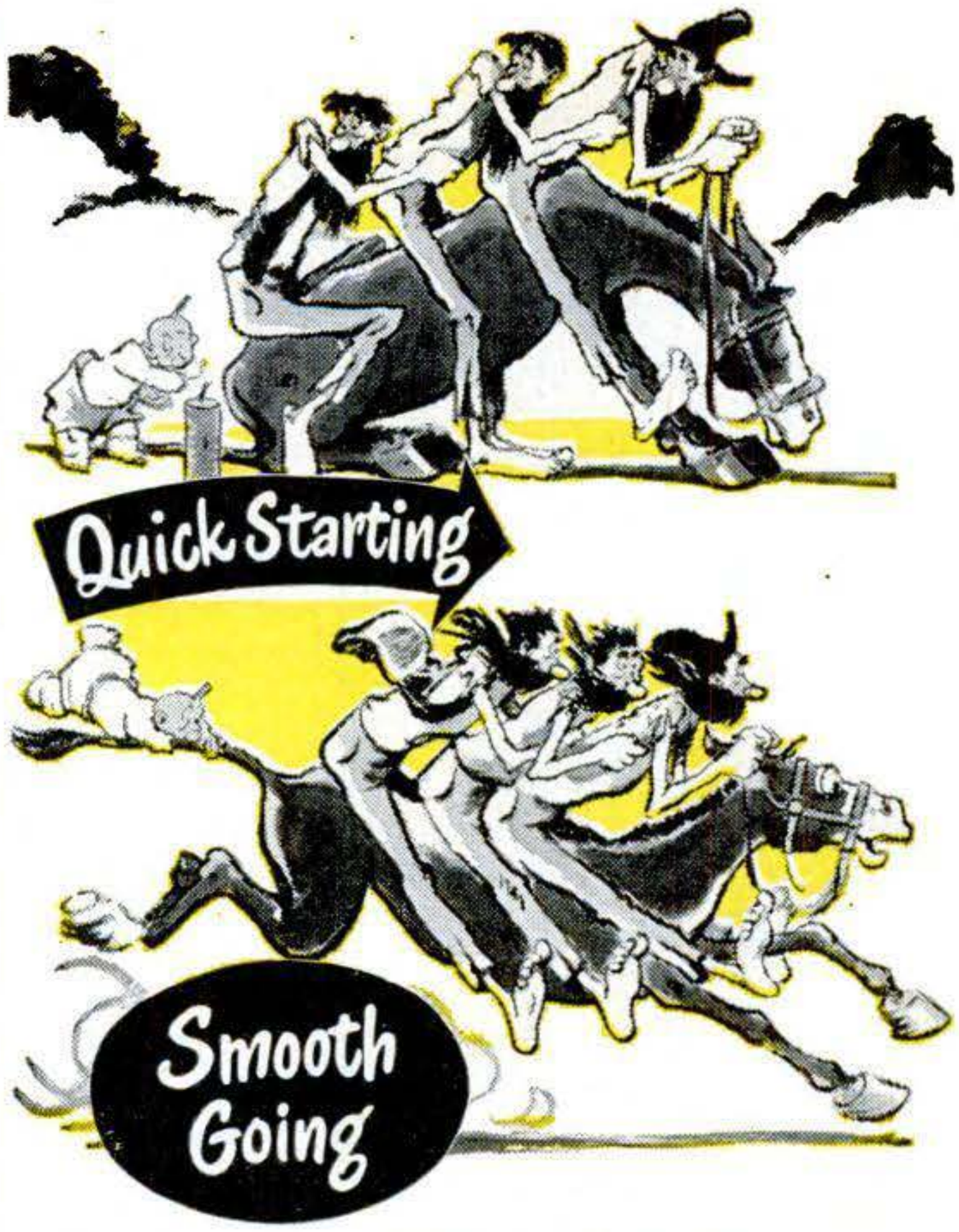

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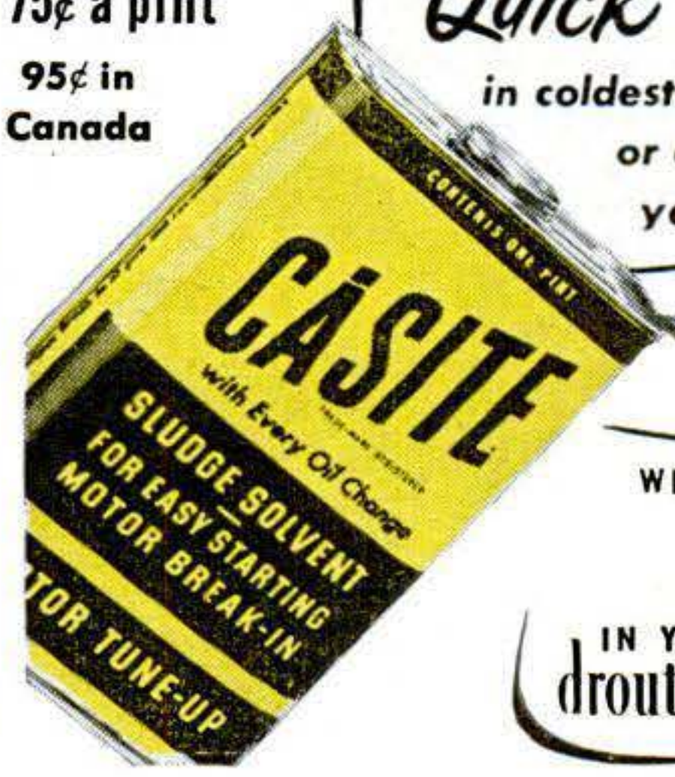

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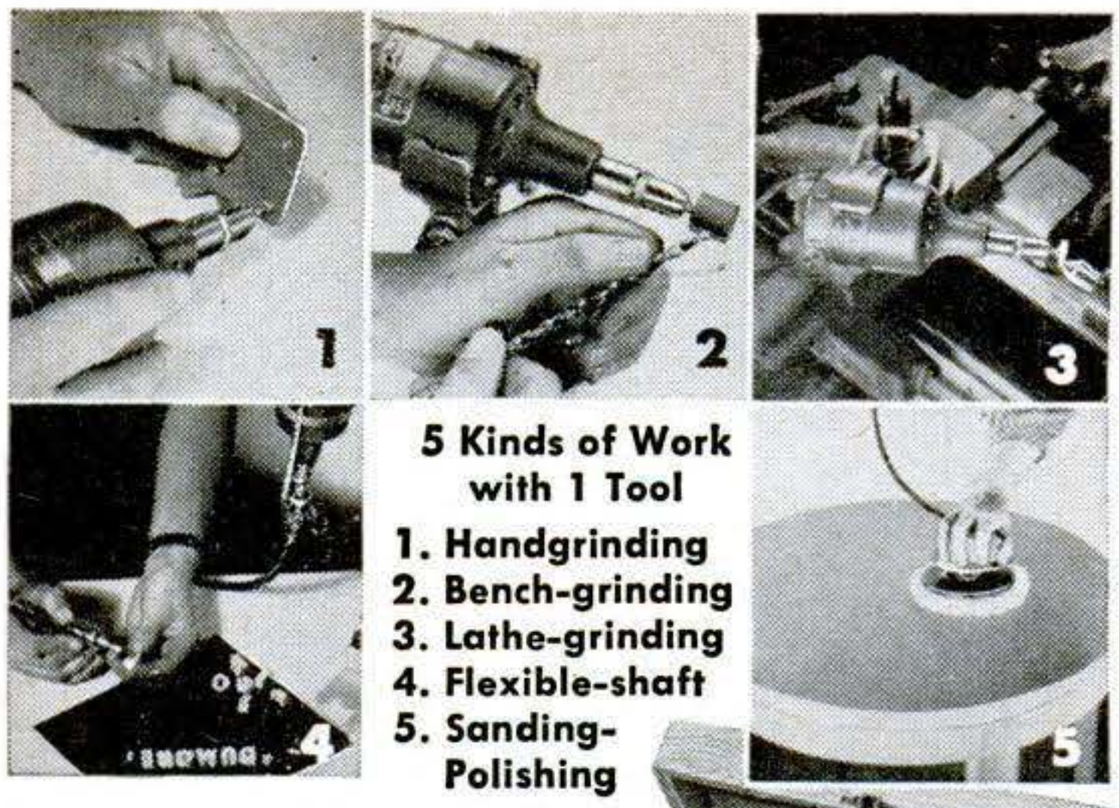

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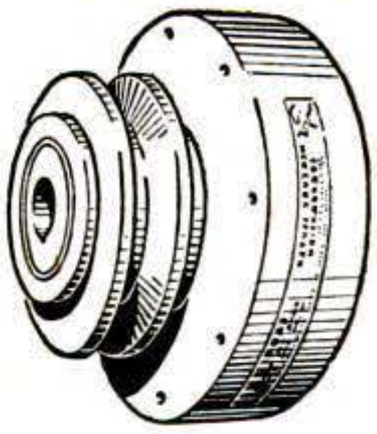

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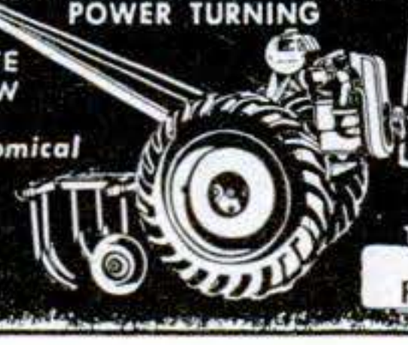

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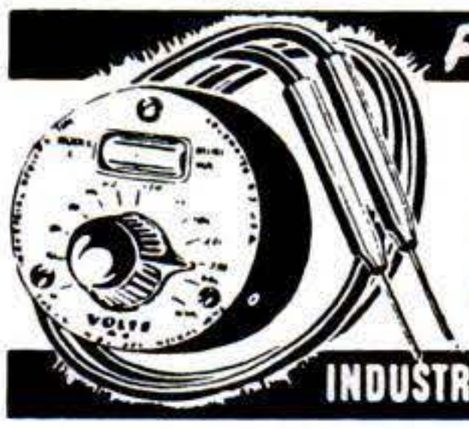

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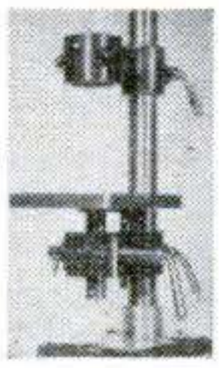

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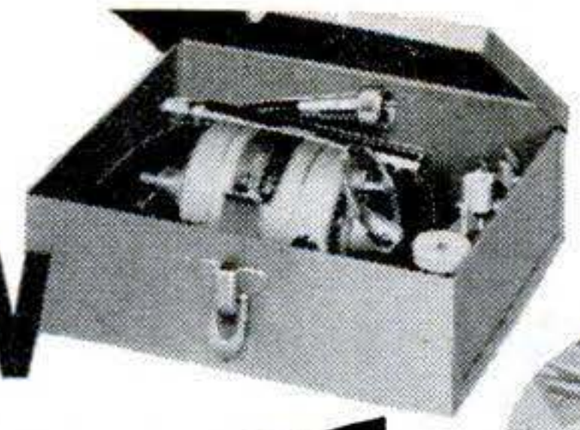

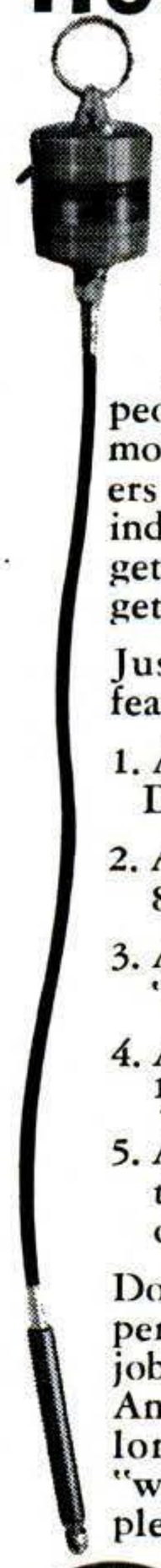

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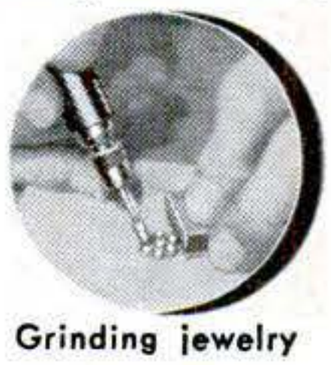

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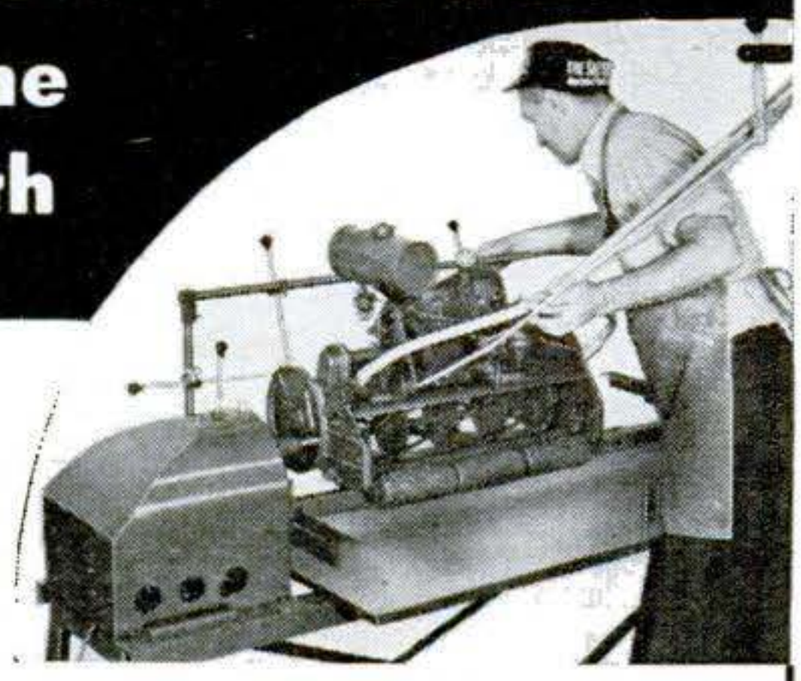

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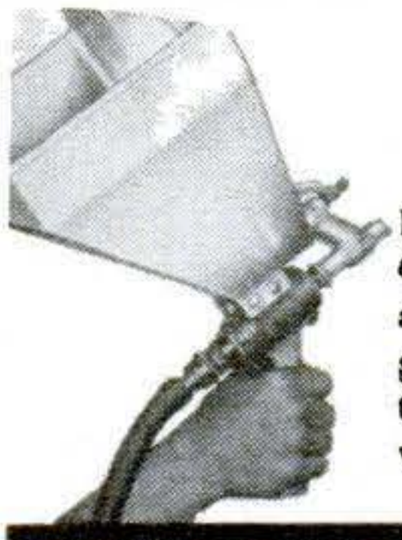

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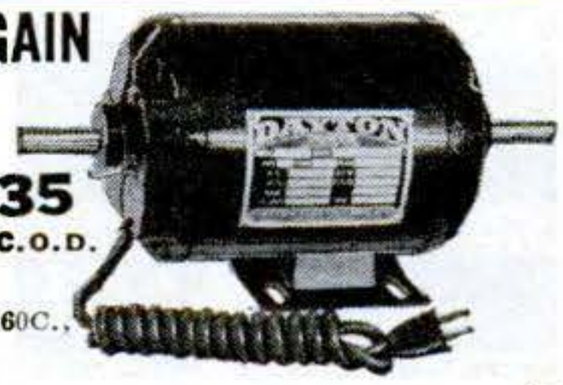

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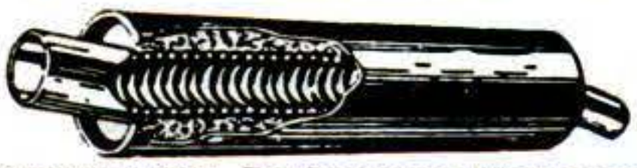

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Car owners who are wasting money and not getting proper gas mileage due to over-rich mixtures will be pleased to learn how to save gasoline by VACU-MATING over-rich mixtures. VACU-MATIC fits all cars, trucks and tractors. It is *automatic* and operates on the supercharge principle. Easily installed in a few minutes.

SALESMEN WANTED! Big Profits! Send name, address on penny postcard for *free particulars* and how to get yours for introducing.

VACU-MATIC CO., 7617-1441 W. State St., WAUWATOSA, WIS.

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OWN A FAMOUS

MOTO-TOOL

The "Pocket-Size Machine Shop"

HIGH-SPEED STEEL CUTTERS —AT NO EXTRA COST

No modern home workshop is completely equipped without MOTO-TOOL . . . the **correctly balanced** motor-in-hand tool. It grinds, drills, routs, carves, polishes . . . **without vibration.** Higher speed does work better, faster, on practically any material. MOTO-TOOL Kit No. 2 includes **high-speed-steel cutters** for longer life, better work. MOTO-TOOL is backed by over 12 years of industrial use . . . packs years of pleasure. Due to wide popularity and increased production, **Dremel's pre-war prices still prevail!**

Moto-Tool No. 2
With Emery Point
$16.50

MOTO-TOOL KIT No. 2
With 23 Accessories
(High-Speed Steel Cutters, Grinding Wheels, Polishing Accessories)
$23.50

DRILL PRESS *(not shown)*
This 12" high precision drill press is ideal for model making, wood carving, routing, etc. Utilizes No. 2 Moto-Tool.
$9.95
(Less Moto-Tool)

LOOK FOR THESE MOTO-TOOL FEATURES

Approximately 27,000 R.P.M. plus dynamically balanced armature provides vibrationless finger-tip control. Moto-Tool has oilless, sealed bearings ● Patented automatic chuck lock pin ● Over-size armature shaft—hardened, ground, polished ● 110 Volt, AC-DC motor ● Sliding snap-type switch ● Cord protector ● Shockproof bakelite housing ● Dust-filtered air-cooling system ● Weighs only 13 oz.

MONEY-BACK GUARANTEE: Buy Dremel Moto-Tools from your dealer. If he cannot supply you, order direct on 5-day trial, money-back guarantee. Shipped postpaid for payment in full (Send check or money order); or, send only **$2** now and pay postman balance plus postage upon delivery. Catalog of Dremel Tools and Accessories FREE.

DREMEL MFG. CO. Dept. T129-A Racine, Wis.

BUILD YOUR OWN POWER LAWN MOWER

WHY BREAK YOUR BACK MOWING FIELD OR LAWN?

WRITE FOR **FREE** Building Instructions The Rite-Way Mower Attachment ▶ Ball Bearing

SAVE MONEY SAVE TIME

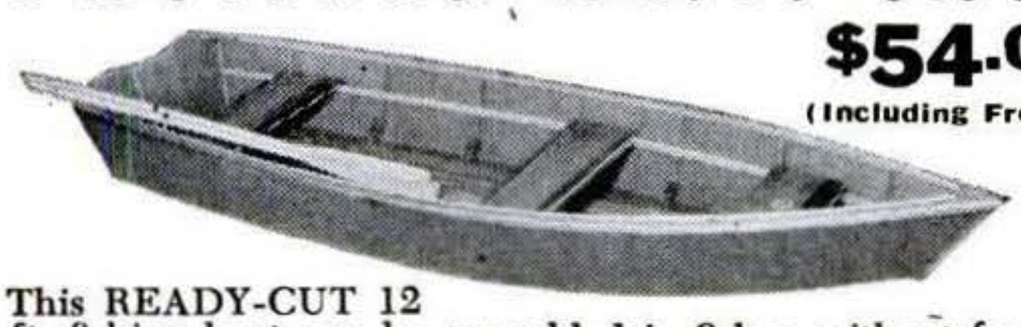
Now anyone can save time and effort mowing field or lawn by building their own whirl type power mower. Build according to your own ideas and needs at small cost. Cut close to fences, walks, buildings, etc. Build in short time with parts and instructions we furnish. Save hours of time and back breaking labor. Write today for FREE information.

IT'S FUN TO BUILD

T & H MFG. CO., Dept. M-123
811 E. 31, Kan. City 3, Mo.

PLYWOOD BOAT KITS

$54.00
(Including Freight)



This READY-CUT 12 ft. fishing boat can be assembled in 8 hrs. without forms or special tools. Kits are complete including all hardware, paint, and etc. Send for free folder.

TAFT MARINE WOODCRAFT
Dept. K 636 39th Ave. N.E. Minneapolis 21, Minn.

NEW *Electric* SANDER

Amazing MOTO-SANDER AND POLISHER

SAVES TIME—SAVES "ELBOW GREASE"

Here's a machine that takes the hard work out of two tough jobs . . . sanding and polishing. **"Moto-Sander"** is so easy to handle that a child can use it . . . so fool proof that, with it, even a novice can do a craftsmanlike job. **Moto-Sander's** fast, straight-line action (non-rotary) eliminates any possibility of wood burns or scratches. Does a magically smooth job of sanding . . . gets into corners and places others can't reach. All **you** do is guide it! There are dozens of time and moneysaving uses in every home and shop for this inexpensive machine. Use **Moto-Sander** to get smooth sanded finish on furniture, painted walls, boats, bird houses, scale models, etc. Use it also for speedy, effortless **polishing** of waxed furniture, automobiles and other surfaces—simply by removing sandpaper and clamping on polishing pad. **Moto-Sander** is the lightest, most practical electric sander on the market—**the only one of its kind.** Furnished with 6 assorted sheets Garnet paper for sanding . . . plus **felt pad** and **sheepskin** for wax polishing. Operates on alternating current. Thousands of satisfied users.

USE MOTO-SANDER AROUND THE HOUSE

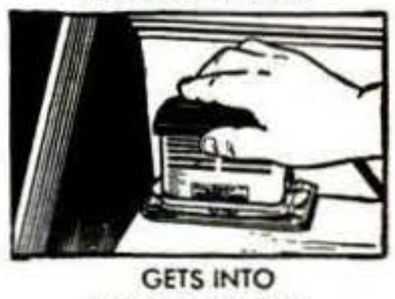
- Sand Furniture and Bookcases
- Sand Stairways, Doors and Woodwork
- Sand Walls before painting
- Polish the Family Car
- Polish Pianos and Cedar Chests
- Polish Waxed Furniture

MONEY-BACK GUARANTEE: Buy Moto-Sander from your dealer. If he cannot supply you send only $14.85 (check or money order) and we will ship postpaid; or, send only **$2** now, and pay postman balance plus postage upon delivery. Your MONEY-BACK if not delighted after 5 days' trial.

DREMEL MANUFACTURING CO.
Dept. SP129-A ● Racine, Wis.

EASY FOR AWKWARD PLACES

SANDS FLAT SURFACES EVENLY



GETS INTO TIGHT CORNERS

ROUNDS CORNERS LIKE MAGIC

New IMPROVED *Electric* MOTO-SAW

Only $5.85
(with 3 Saw Blades)
Postpaid

SAFE AS A HAND SAW
JUST GUIDE IT!
The versatile MOTO-SAW
is as safe as a handsaw. A touch of the trigger switch sets it going . . . releasing stops it instantly.

Saws to Center of 19" Widths
No Limit to Length of Stock it Will Cut

THOUSANDS OF SATISFIED USERS

AVERAGE CUTTING SPEED ONE FOOT PER MINUTE

Moto-Saw works more like magic than any tool you ever saw! Takes no effort to run . . . no perceptible pressure to feed . only a trifle heavier than a hand scroll saw, and better balanced in your hand. Runs 7200 strokes a minute . . . leaves no rough edges . . . easily cuts intricate scroll designs in medium hard wood up to ¾" thick. Blade holder faces blade 1 ways . . . permits sawing sideways as well as forward and backward Sturdily constructed . . . only two moving parts . . . never needs oiling . . . requires no bench room or floor space. Operated on alternating current. Thousands of satisfied users.

MONEY-BACK GUARANTEE:—Buy Moto-Saw from your dealer. If he cannot supply you, send only $5.85 for Moto-Saw and 3 blades, postpaid; or, send only $2.00 now, and pay postman balance plus postage upon delivery. MONEY-BACK if not delighted after 5 days' trial.

DREMEL MFG. CO. ● Dept. S129-A ● Racine, Wis.

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SAVE TIME AND WORK! MAKE EXTRA MONEY!

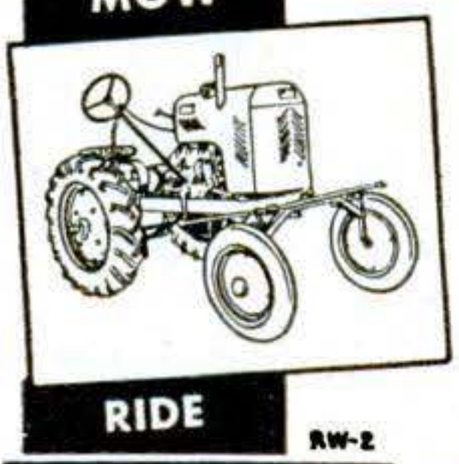
SHAW "DU-ALL" and "PEPPY PAL" GARDEN TRACTORS

PLOW

HARROW

CULTIVATE

MOW



RIDE

These sturdy walking and riding tractors ideal for dozens of uses around the farm, orchard, garden, golf course, estate and poultry farm.

DO DOZENS OF JOBS
Shaw Du-All or Peppy-Pal tractors do many jobs quickly and easily. Plow, cultivate, harrow, mow, disk, bulldoze, spray, grind, haul and saw wood. New uses discovered every day.

BUILT FOR RUGGED WORK
Sturdy, extra-strength construction means low upkeep, long life. Patented tool control allows quick shift for crooked rows. Attachments easy to change with new "Jiffy Hitch."

CHEAP TO OPERATE
Operates on few cents an hour. Soon pays for itself in time and labor-saving plus low initial and operating costs.

LOW FACTORY PRICES
Buy direct or through your dealer! Almost anyone who has a garden can afford a Shaw Du-All or Peppy-Pal. Full year's guarantee.

RIDING TRACTORS
Four models, from 5 to 12½ H.P., 58 in. wheelbase, 36 in. wide, 24 in. plant clearance. Hand or electric starter. Improved steering device, brakes enclosed in differential housing shaft. Standard hitch for trailers and wagons. Plow, harrow, cultivator, cutter bar, snow plow, bulldozer available.

PROMPT SHIPMENT
No waiting—order now for immediate delivery.

RW-2

FREE: Illustrated folders giving complete details and price lists. Write today:

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It's NORTHLAND SKI Time!

THE TIME OF THE YEAR
for the time of your life!

Pack the season with thrills. Race your favorite slope with the sure-footed control of perfectly matched, hand-crafted Northland Skis. Northlands are ideal to own, ideal to give. Send 15c for the famous Northland Ski Manual, or, write for free pamphlet.

NORTHLAND SKI MFG. CO.
Supplier to the U.S. Olympic Ski Team
94 MERRIAM PARK • ST. PAUL 4, MINNESOTA

BUILD YOUR OWN TRAILER

$26.35
Minus Tires and Tubes 10% with Order Bal. C.O.D.

Ideal for building stock and boat trailers, spray carriers, feed, fence, post, horse or general utility trailer, and for mounting under elevators. Timken bearings, 59" tread, 16" demountable wheels, solid steel 1½" square axle, 4,000 lb. cap. (Ask about wider tread widths). NEW—we manufacture these—NOT SURPLUS ITEM! Stub assemblies also available. Order from ad.

DEALERS! Write for Discounts
STANDARD EQUIPMENT CO., Dept. 14A, Cedar Rapids, Iowa

JUMBO HEAVY DUTY JACK KNIFE

15⅝" OPEN
14 Ozs.

Handy around
- ORCHARDS
- SHOPS
- SHIPPING ROOMS

Great for HUNTERS, TRAPPERS, SCOUTS, CAMPERS, etc.

Send Check or M.O. **$2.95 EACH**

JUMBO JACK KNIFE CO.
2452 W. 28th ST., GRAND RAPIDS, MICH.

Your weight does the work with a "YANKEE"

QUICK-RETURN SPIRAL SCREW DRIVER

● Save your wrist: drive and draw screws faster. Just push on a "Yankee" 130A Spiral Driver. Your weight and the spiral turns the screw without blisters or fatigue. Quick-return spring in handle holds blade in slot and returns the handle after every stroke.

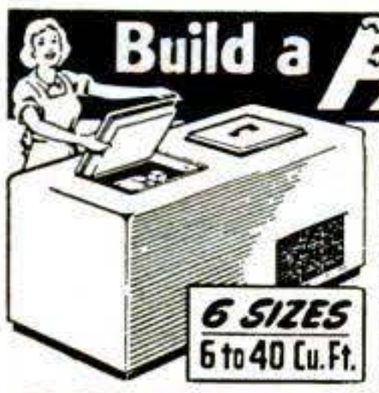
★ Write for the "YANKEE" Tool Book ..FREE..

"YANKEE" TOOLS NOW PART OF STANLEY

THE TOOL BOX OF THE WORLD

NORTH BROS. MFG. CO.
Philadelphia 33, Pa.

Build a FAST-FREEZER



It's easy to build this household appliance with LeJay Plans. Made from new or used parts. Save up to 50%. No expert knowledge needed. Plans show 6 sizes and are easy to follow. All details clearly explained. Enjoy making one of these freezers. Mail $1.00 for set of plans and catalog.

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CASH IN ON THE BUILDING BOOM

Only $199

Amazing, General High-Speed low cost Concrete Vibrator Block Machine. Will produce 1000 blocks in an 8 hour day. All sizes. Easy to start your own profitable business. Complete details sent FREE. Mail $1 for WONDERFUL BOOK "How To Build Your Own Concrete Block Home."

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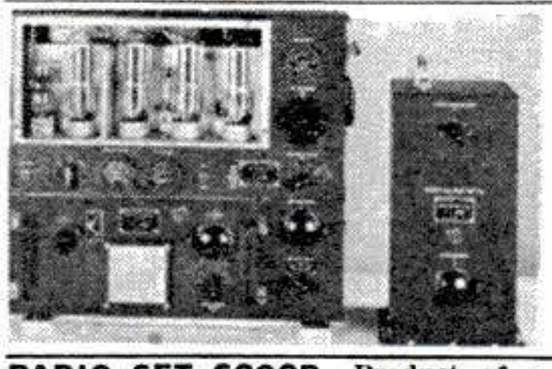
Buffalo Radio Supply, one of America's largest electronic distributors, is in a position to supply most of the requirements of foreign purchasers. Directly from its gigantic stocks or those of its affiliates. Export inquiries are solicited both from export houses and from foreign govt. purchasing commissions here and abroad. Expense can be reduced and requirements filled with a minimum of delay by contacting Buffalo Radio Supply initially.

OUR PE-109 DIRECT CURRENT POWER PLANT

This power plant consists of a gasoline engine that is coupled to a 2000 watt 32 volt DC generator. This unit is ideal for use in locations that are not serviced by commercial power or to run any of the surplus items that require 24-32v-DC for operation. The price of this power plant tested and in good condition is only $79.95 F.O.B. Buffalo, or we can supply in strictly "as is" condition for $58.95 F.O.B. New York City. These latter are exactly as received, in heavy steel-strapped gov't cases, and we are unable to determine if the individual units are new, or what the condition is if used, while the $79.95 are some of the same that we have brought to Buffalo for testing and repair if necessary. We do not recommend gambling on the "as is" condition, except for quantity purchasers. We can also supply a converter that will supply 110v AC from the above unit or from any 32v DC source for.....**$12.95**

HEAT GUN Streamlined pistol grip heat gun in vivid red housing, that delivers a powerful 20 Cubic Ft. per minute blast of hot air at 160 Fahrenheit. Ordinary blowers have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that produces a hurricane of either hot or cold air. Perfect for blowing out dirt or dust from radio chassis, drying out ignition systems, warming up carburetors, quick-drying paint, thawing out radiators or water pipes, etc. Warning:—Keep this away from your wife, or she will be using it to dry her hair because it will do it in half the time of her ordinary hair dryer, to say nothing of her using it to dry stockings or clothing, or defrost the refrigerator instantly. Only **$12.95.** Satisfaction guaranteed or money refunded if returned prepaid within 5 days.



General Electric
150 Watt Transmitter

Cost the Government $1800.00. Cost to you —Brand New..... **$100.00**

The most famous of all surplus transmitters. Was used by air force ground stations and bombers during the war. Will work on all important bands or frequencies. Complete with power supply. Send for free descriptive literature. Quantity limited.

RADIO SET SCOOP. Product of a famous aircraft radio manufacturer who has abandoned the manufacture of table model radios because of the flood of government orders. All in 5 ply genuine mahogany cabinets, both regular and bleached. Original list price given first—then your cost. Sensational discounts. Model 565 is 5 tube, all others are 6 tube.

Model 565,	Mah. or blonde	$ 34.95	**$ 16.97**
Model 6618,	Mah. or blonde	$ 44.95	**$ 20.97**
Model 663,	Mah. or blonde	$ 46.95	**$ 21.97**
Model 612,	Walnut	$ 36.70	**$ 17.95**
Model 613,	Mahogany	$ 42.05	**$ 19.95**
Model 6612,	Blonde Mahogany Console	$215.00	**$105.00**

AUTO RADIO DEALERS ATTENTION

Nationally advertised brand 1949 car radio that will fit practically any car. These car radios will be surefire hits with your customers. They have plenty of eye appeal plus a host of other features that no other radio regardless of cost can offer. Here are but a few of them: Built-in battery charger that will keep a car battery fully charged even if radio is played all day long. An outlet so an electric shaver or similar electrical appliance can be used while driving along highway. The radio is a powerful 6 tube superheterodyne that has a three-gang condenser and a stage of radio frequency amplification for increased sensitivity. The radio, complete with the built-in battery charger and power outlet, is a single compact unit that is easily installed. Sample—$40.50; Dealer price, **$37.47** each in lots of two or more.

RT-1711 Brand New 12 Tube, 110 Volt Receiver-Indicator-Oscilloscope complete with all tubes and power supply. Has telescoping hood over scope tube, which is equipped with a detachable calibrated screen. Has centering and amplitude controls and two video inputs. A natural for television.....**$39.95**

RT-1655—11 tube crystal controlled **SUPERHETERODYNE RECEIVER** that covers the FM band. The ultra modern circuit uses the latest types of tubes. Beautiful chassis and aluminum cabinet. Tubes and schematic supplied.....**$14.95**

REMOTE CONTROL UNIT: Aluminum case 4x3x2" containing 2 potentiometers, triple pole switch, 4 knobs, gear mechanism, counter and phone jacks.....**99c**

Latest type PM Speaker in a fully-enclosed black crackle finished metal cabinet. This speaker and case match communication receivers, and in addition make perfect intercom remote stations. Our price **$4.50.** Including output transformer.....**$4.95**

MIDGET 1 WATT RIG supplied complete with polystyrene coil forms for 3 ham bands. Size overall 3"x1"x2½" high. Includes practically all necessary parts. Details on page 62 of January 1944 QST. Your cost **$1.50**

Battery pack for the 1 watt transmitter supplying 90 volts "B" and 1.5 volts "A".....**$1.50**

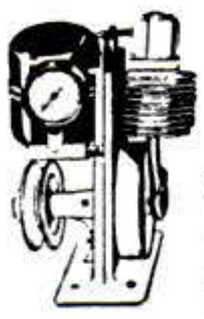
110 V. AC power supply kit for the 1 watt transmitter.....**$3.50**

Super Special—Highest quality all chrome bullet shaped **CRYSTAL MIKE** of topflight nationally known brand.....**$5.95**

Book on **DRY DISC RECTIFIERS** by H. B. Conant, nationally recognized authority on the subject. Theory and practical applications **25c**

World renowned 700 page tenth edition of the RADIO HANDBOOK in cloth binding and hard cover at the sensational reduced price, for a limited time only.....**$1.49**

COMPRESSED AIR INSTANTLY, Anywhere!!



Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball-bearing on connecting rod and oil impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors. Patented unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver appr. 3500. cu. in. air per min. at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than 1 min. Complete with 100 lb. gauge, fingertip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any ¼ H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides; annealing or brazing with natural gas, inflating tires; etc. Price **$14.50** postage prepaid anywhere in U.S. Efficient, adjustable siphon type spray gun complete with 12 ft. of 100 lb. tested hose for only **$7.75** with pint container, also prepaid. 25% required on C.O.D. orders. Send for free catalogs of radio parts and surplus items.

DUAL METER One 50 uA and one 200 uA movement in the same case. This meter is ideally suited for use as a combination modulation percentage and carrier shift indicator. If desired the movements may be removed from the case and used separately for voltmeters, ohmeters, ammeters, etc. All meters are in perfect operating condition, but a few have cracked glasses. This super value costs only.....**$1.75**

Terrific Value only $20.95

Equipped with ¼" Jacobs Geared Chuck and Key

PORTABLE ELECTRIC DRILL

Not an intermittent duty drill, but a full size rugged tool. Most convenient type switch, natural grip handle, and balance, like a six-shooter. Precision cut gears—turbine type cooling blower—extra long brushes. No stalling under heaviest pressure because of powerful 110 Volt AC or DC motor and multiple ball bearing thrust. Other bearings self-aligning lifetime-lubricated Oilite type. Made for toughest year-in and year-out service in plant or on construction jobs. Amazing perpetual factory guarantee assures you of a lifetime of trouble-free use. *Full refund (you pay transportation) if not pleased with drill after trial.*

One hundred resistors	**$1.95**
Ten Metal & Bakelite Knobs (no wooden knobs)	**.39**
Six variable condensers, including butterfly types	**1.49**
Ten R.F. Chokes, including high frequency types	**.35**
Four volume controls without switches	**.95**
Seven I.F. Transformers	**1.98**
Five Oscillator coils	**.69**

The above 7 assortments listed, can be purchased together as one lot at a superspecial total price of only **$6.95.** All merchandise guaranteed to be as advertised.

STUPENDOUS VALUE in 3 Section PERMEABILITY TUNER

The entire variable tuning section of a deluxe current model General Motors radio. Amazingly tiny (4x3x2½), though truly half of a radio. Shielded R.F. sections litz wire wound. All 3 tuned circuits adjustable at both low and high ends of dial. Compact enough to be used to pep up any 2 or 3 gang superhet or 2 gang TRF. Will substitute for entire original tuning system including variable condenser or if desired the original tuning condenser can be connected to these coils, and the coils set to proper inductance (no instruments required), and the set tuned just as before, although much greater sensitivity and selectivity will result. Can be used as a multiple section wavetrap that will cut out undesirable interference as with a knife. If only a little bit better than average results with a slug-tuned wavetrap are necessary, the unit can be split up in a couple of minutes into 3 coils that can be used on 3 different jobs. These coils, supercompact and really hot, can also individually replace any broadcast band RF, Oscillator, or 1st detector coil with improvement in results in any set. After seeing one of these units, you'll order a dozen just for general repair or replacement work. Cost the manufacturer several dollars. Your cost **$1.49**

"Don't get your fingers burnt"

Use the New Amo Miniature Tube Puller

Save time and money by speedily inserting or extracting tubes in the hard-to-reach places. **99c**

GENERAL ELECTRIC 15-TUBE TRANSMITTER AND RECEIVER SET

This brand new 15 tube transmitter-receiver was designed for mobile service on 12 volts, and will operate in the "Citizens' Band," where no amateur license to transmit is necessary. It's a cinch for any experimenter to connect this unit for 110 VAC operation by following the instructions and diagrams supplied, which cover numerous applications, including television. For those intending to use on car or boat, a new dynamotor, exactly as originally supplied, costs only $15.00. Don't fail to write for FREE descriptive bulletin. Order our **RT-1248** for only **$29.95,** or two for **$53.90**

SCR-274N COMMAND SET

The greatest radio equipment value in history

A mountain of valuable equipment that includes 3 receivers covering 190 to 550 KC; 3 to 6 MC; and 6 to 9.1 MC. These receivers use plug-in coils, and consequently can be changed to any frequencies desired without conversion. Also included are two Tuning Control Boxes; 1 Antenna Coupling Box; four 28 V. Dynamotors (easily converted to 110 V. operation); two 40-Watt Transmitters including crystals, and Preamplifier and Modulator. 29 tubes supplied in all. Only a limited quantity available, so get your order in fast. Removed from unused aircraft and in guaranteed electrical condition. A super value at **$34.95,** including crank type tuning knobs for receivers. Without these knobs the receivers can't be tuned, and are only useful for parts. Don't buy without knobs!

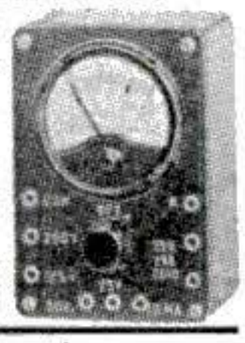
$10.95 TAKES ALL THREE BIG BARGAINS

1. SENSATIONAL, FASCINATING, MYSTERIOUS SELSYNS. Brand new Selsyns made by G.E. Company. Two or more connected together work perfectly on 110V AC. Any rotation of the shaft of one Selsyn and all others connected to it will rotate exactly as many degrees in the same direction, following unerringly as if the units were connected together by shafting instead of wire. This is true whether you twist the shaft of the master unit a fraction of a revolution or many revolutions. Useful for indicating direction of weather vanes, rotating directional antennas, or controlling innumerable operations from a distance. Complete with diagram and instructions. Per Matched Pair.....**$4.95**

2. ALUMINUM GEAR BOX 18x8x7 that contains two powerful electric motors and two matched gear trains. 62 gears in all varying in size from ½ to 4" in diameter. This unit is readily converted to rotate a beam antenna or any other similar use.....**$5.00**

3. HOME WORKSHOP AT BARGAIN PRICE. Accurate and precise 2 speed guaranteed hobby lathe, the essential machine for the home workshop. Sturdy enough for light production work or factory standby service. Supplied with 56" of belting for connecting to any available electric motor or power take-off. Also including in this unbelievable offer are such accessories as a ½" drill chuck with specially hardened tool steel jaws, a 4" electric furnace high speed grinding wheel, a cotton buffing wheel with a large supply of buffing compound, and a 4" steel wire scratch brush. Your cost **$6.00.** Sole export agent. Distributor inquiries invited.

SENSATIONAL VALUE IN AC-DC POCKET TESTER



This analyzer, featuring a sensitive repulsion type meter housed in a bakelite case, represents the culmination of 15 years achievement in the instrument field by a large company specializing in electronic test equipment.

Specifications of the AC-DC Model Volt-Ohmmilliammeter: AC Volts—0-25, 50, 125, 250; DC Volts—0-25, 50, 125, 250; Milliamperes AC—0 to 50; DC Milliamperes—0 to 50; Ohms Full Scale—100,000; Ohms Center Scale—2400; Capacity—.05 to 15 Mfd.

Total Price, prepaid anywhere in the USA—**$7.00**

Similar DC Meter, lacking the AC operated ranges of above.....**$5.50** prepaid

All sales final and no returns unless otherwise specified in ad of item. Right reserved to change prices and specifications at any time.

BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. PS BUFFALO 3, N. Y.

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Announcing

THE REVOLUTIONARY NEW BOICE-CRANE

FRICTION-MATIC WET TOOL GRINDER

SIMPLIFIED SELF-ADJUSTING FRICTION ROLL DRIVE. No countershaft or extra belt.

PERIPHERAL SPEED REMAINS CONSTANT AS WHEEL WEARS. Exclusive feature.

NO WATER THROWN ON OPERATOR. Has "controlled-water action".

PERMITS PROPER PRESSURE CONTROL. Operator takes a comfortable standing position and works on top of the wheel.

LARGER TOOL REST (2½" x 5"). Perfect for long, slim knives, wide tools.

ACCURATE CONTROLS FOR GRINDING ANGLES FROM ZERO TO 30°. First tool rest with adequate adjustment.

8" DIAMETER and 1½" FACE SANDSTONE WHEEL. 135 r.p.m. increasing as wheel wears to maintain peripheral speed of approximately 280 feet per minute.

GRAY ENAMELLED STEEL CASE. 16 gauge. Weight 14 lbs. net; 17 lbs. packed.

Only $16.50

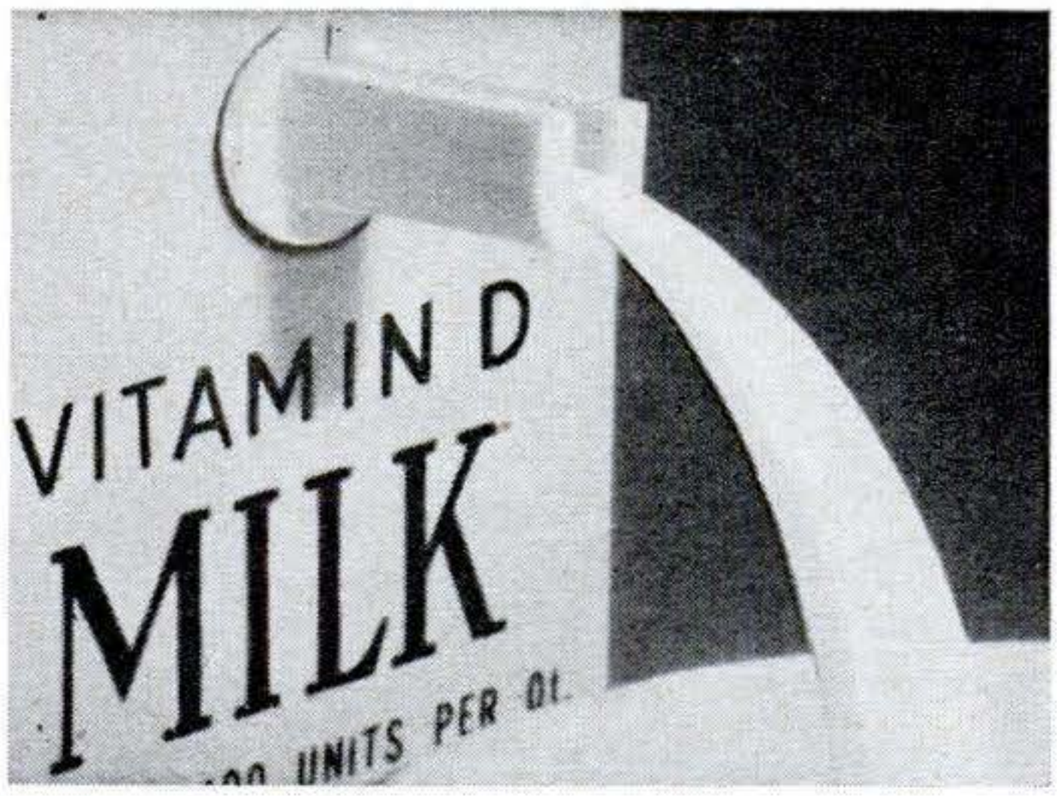
Order today from Power Tool Dealers Everywhere.

BOICE-CRANE COMPANY

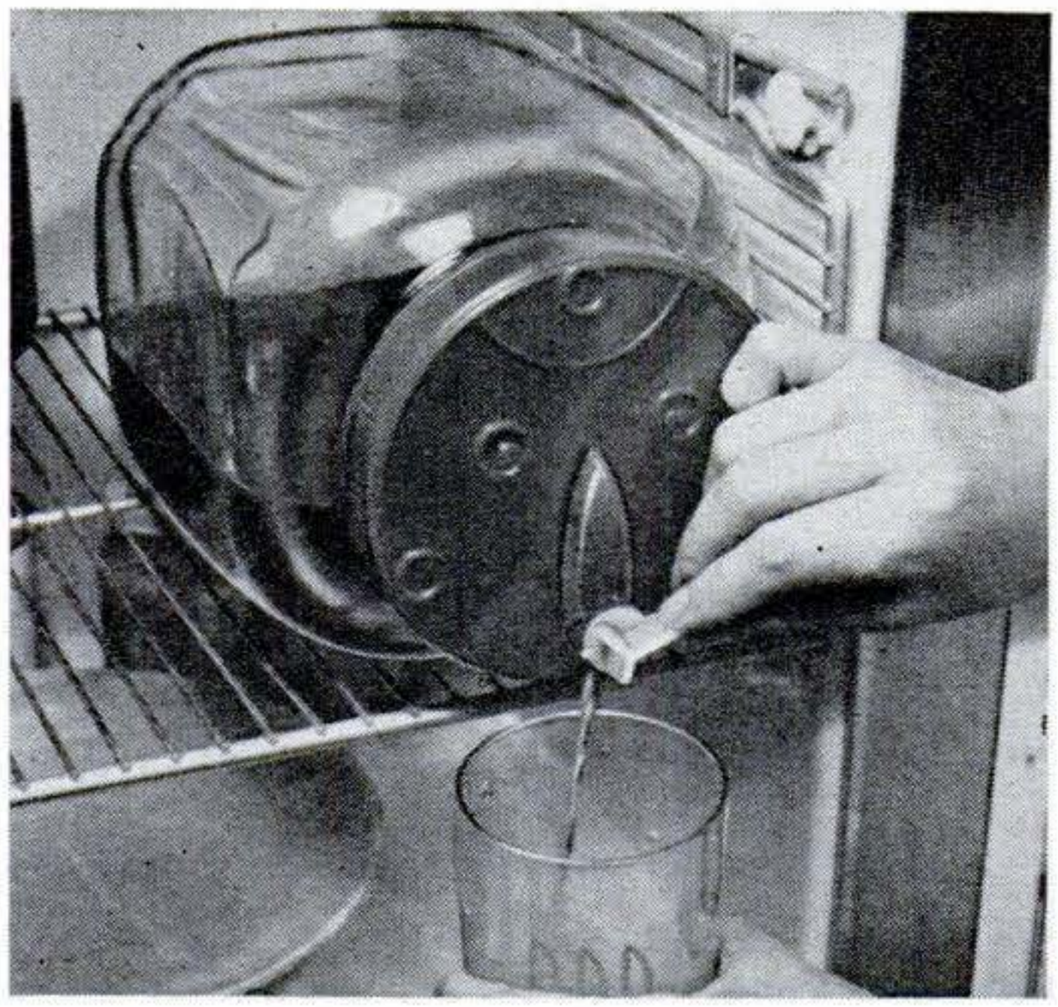
944 CENTRAL AVENUE • TOLEDO 6, OHIO

THICKNESS PLANERS • SPINDLE SHAPERS • SAW-JOINTERS • LATHES • TILTING-ARBOR SAWS • BELT SANDERS • SPINDLE SANDERS • BAND SAWS • JIG SAWS • DRILL PRESSES

Aids to



Plastic Cream Separator. To draw the cream off the top of a cardboard container of milk, all you do is plug the Lustron® separator through the side of the container. The gadget is tasteless, odorless, acid resistant, and can be used over and over again. It is sold by the J. A. Danielson Company, of Richmond, Calif.



Refrigerator Jug Has Spigot. Fine for storing fruit juices, iced tea, or ice water, this square-style refrigerator jug occupies a minimum of space, and the spigot makes it a simple matter to draw what you need. The removable, easy-to-clean top and spigot are molded of plastic. The Haskey Co., of Chicago, is the distributor.

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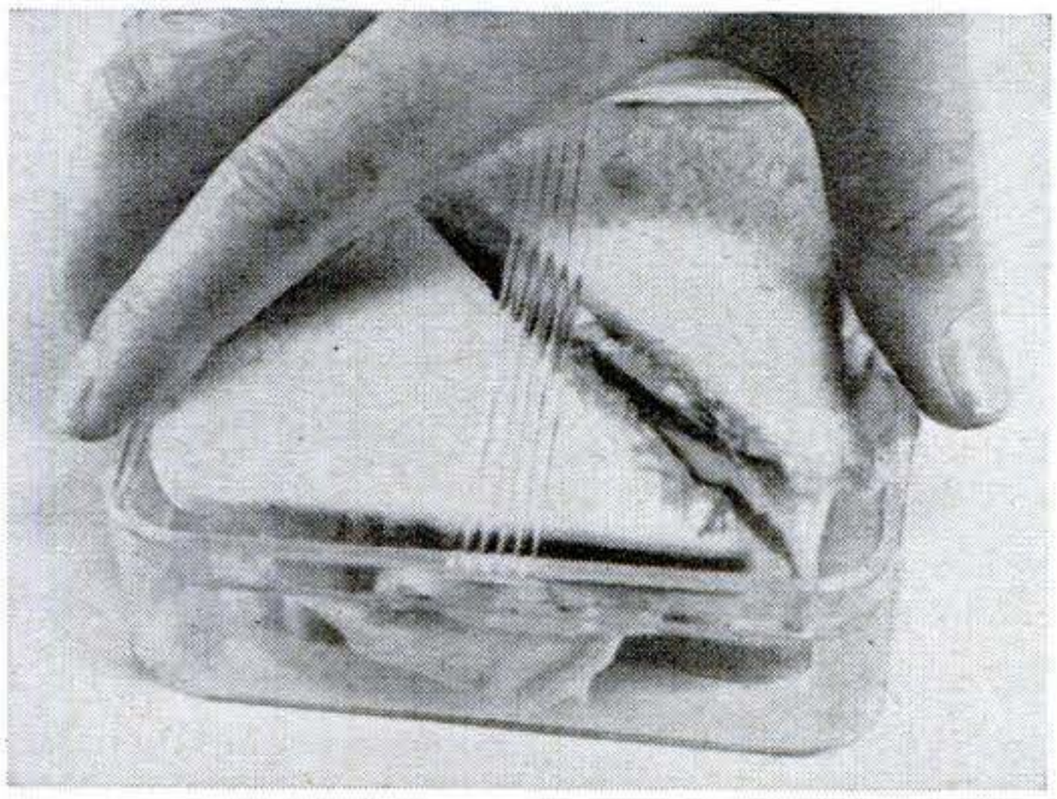
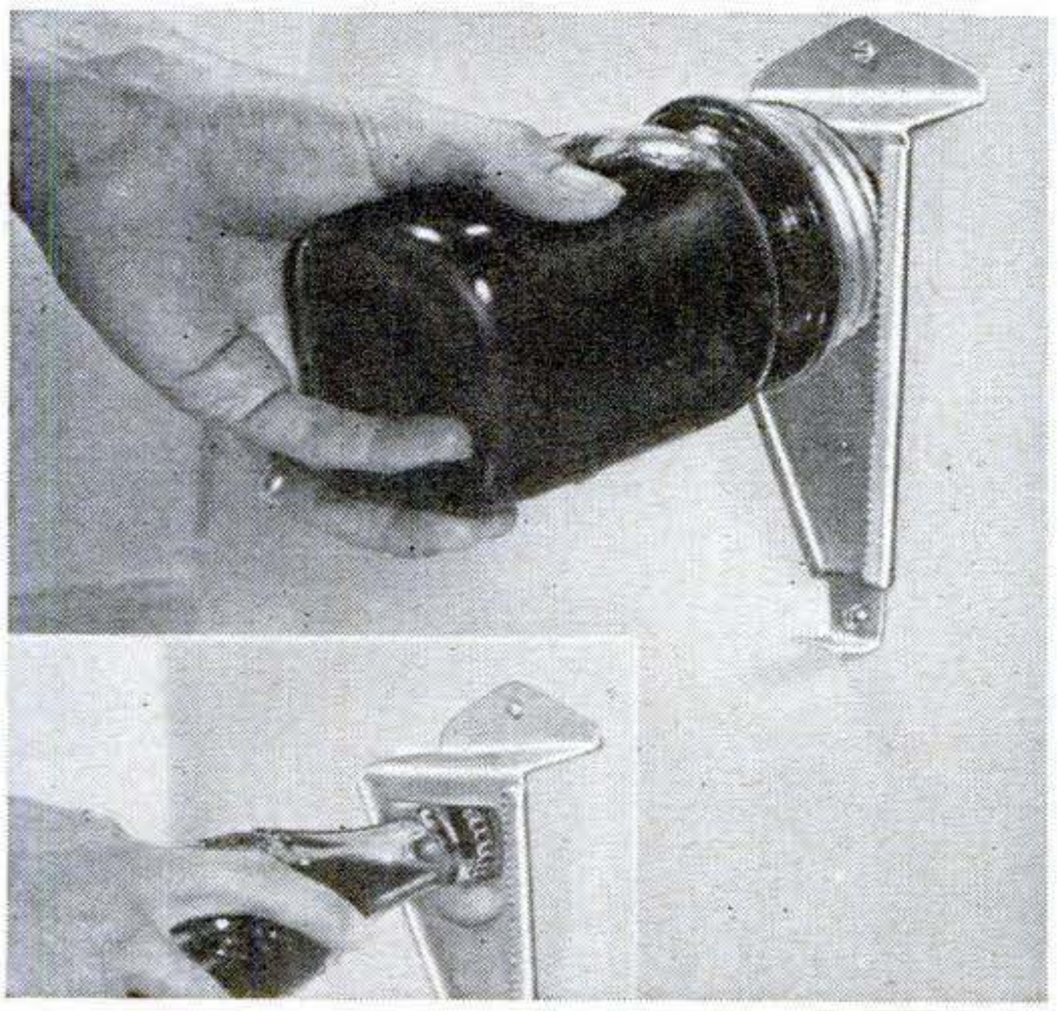
Modern Living



Keeps Sandwiches Fresh. With this new clear plastic box, you now can carry a sandwich in a lunch box, pocket, or purse without crushing it. Designed especially to hold a sandwich, it is 4¾″ square by 1¼″ deep. The boxes also are used to store refrigerator leftovers. They're priced at 20 cents each by Pilgrim Plastics Co., Los Angeles.



Opener Removes Any Jar Top. A toothed, V-shaped opener of rustless steel, the Triple Topper®, will cope with any jar or bottle. Screw jar tops are slipped into the V until the teeth take hold, and the jar is then turned. For bottles, there is the opener shown in the inset. The L. L. Fike Metal Prod. Co., Independence, Mo., is the make-

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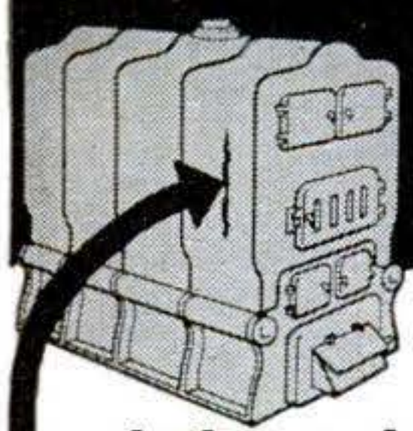

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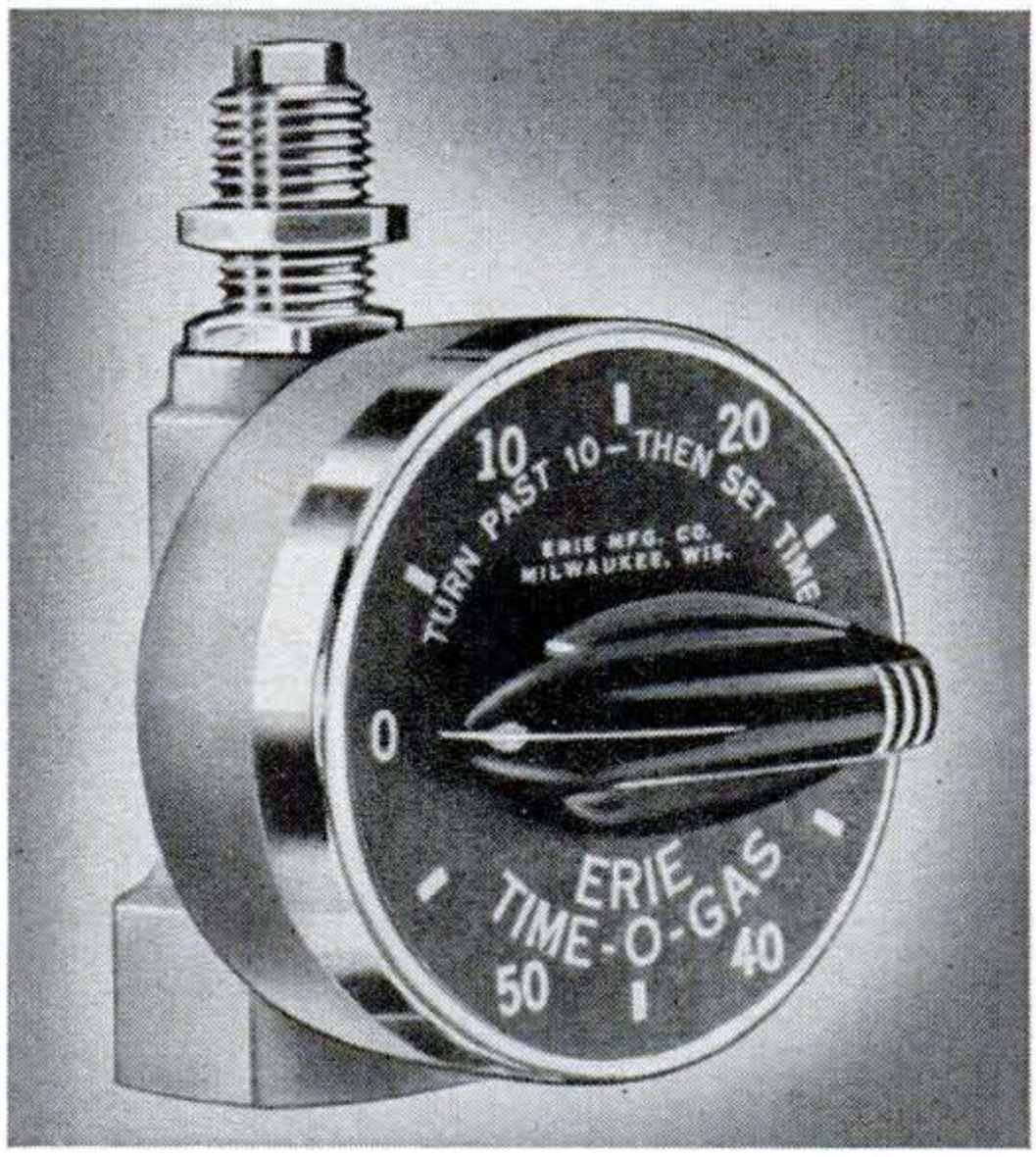
Aids to Modern Living

Wallpaper Border for Nursery. Two printed wallpaper borders for the nursery—depicting a circus parade and nursery rhymes—are offered by the Belmont Press, of St. Clairsville, Ohio, at about $3 each. The continuous strips are available in two colors, blue or yellow. The rhyme strip includes a prayer for each day.



Times Gas Water Heaters. This timer, installed in place of the manual control on a gas water heater, automatically shuts off the gas after any set period from two to 55 minutes. The maker, Erie Manufacturing Co., of Milwaukee, Wis., recommends use of the timer with manufactured or natural gas but not with bottle gas.

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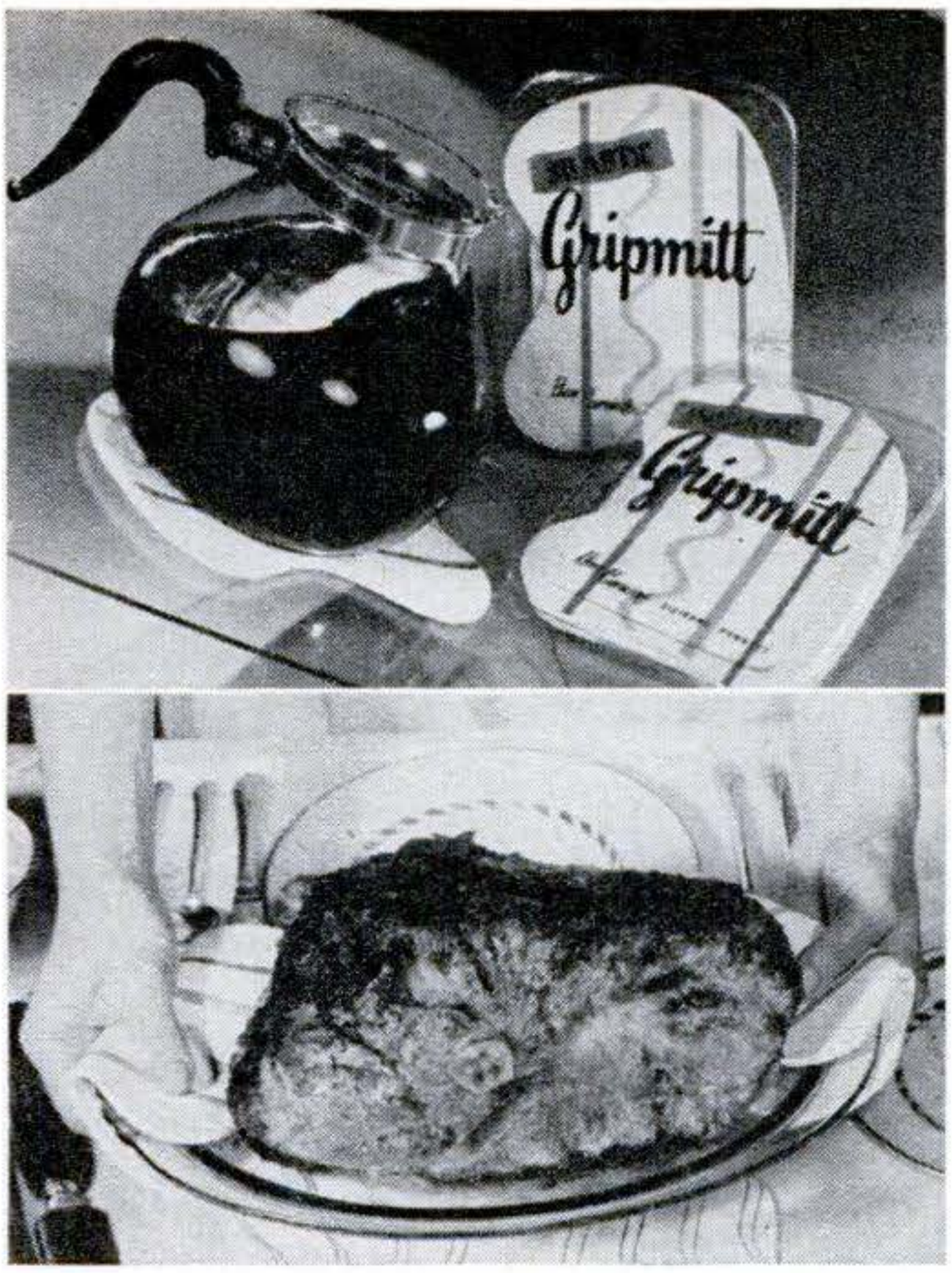
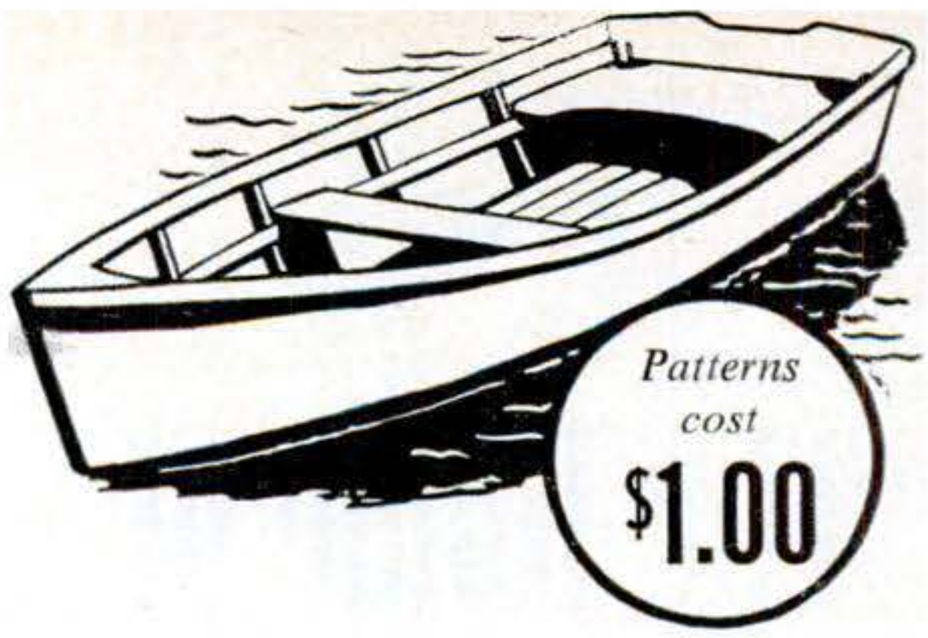


New Pot Holders Are Skid-proof. Table mats, place mats, and pot holders of Silastic®, a silicone rubber, are slipproof, heatproof, and steamproof, according to the manufacturer, Dow Corning Corp. The top photo demonstrates a glass coffee maker held securely on a slanting surface by one of the mats. The material holds its color and can be cleaned easily by wiping with a cloth and water.

Dustpan Stays Put. No stooping is required with this dustpan made of synthetic rubber. It is held at the proper angle on the floor by rubber feet that also prevent it from sliding. You just place the pan on the floor and sweep the dirt into it. The manufacturer is the Wooster Rubber Co., Wooster, Ohio.



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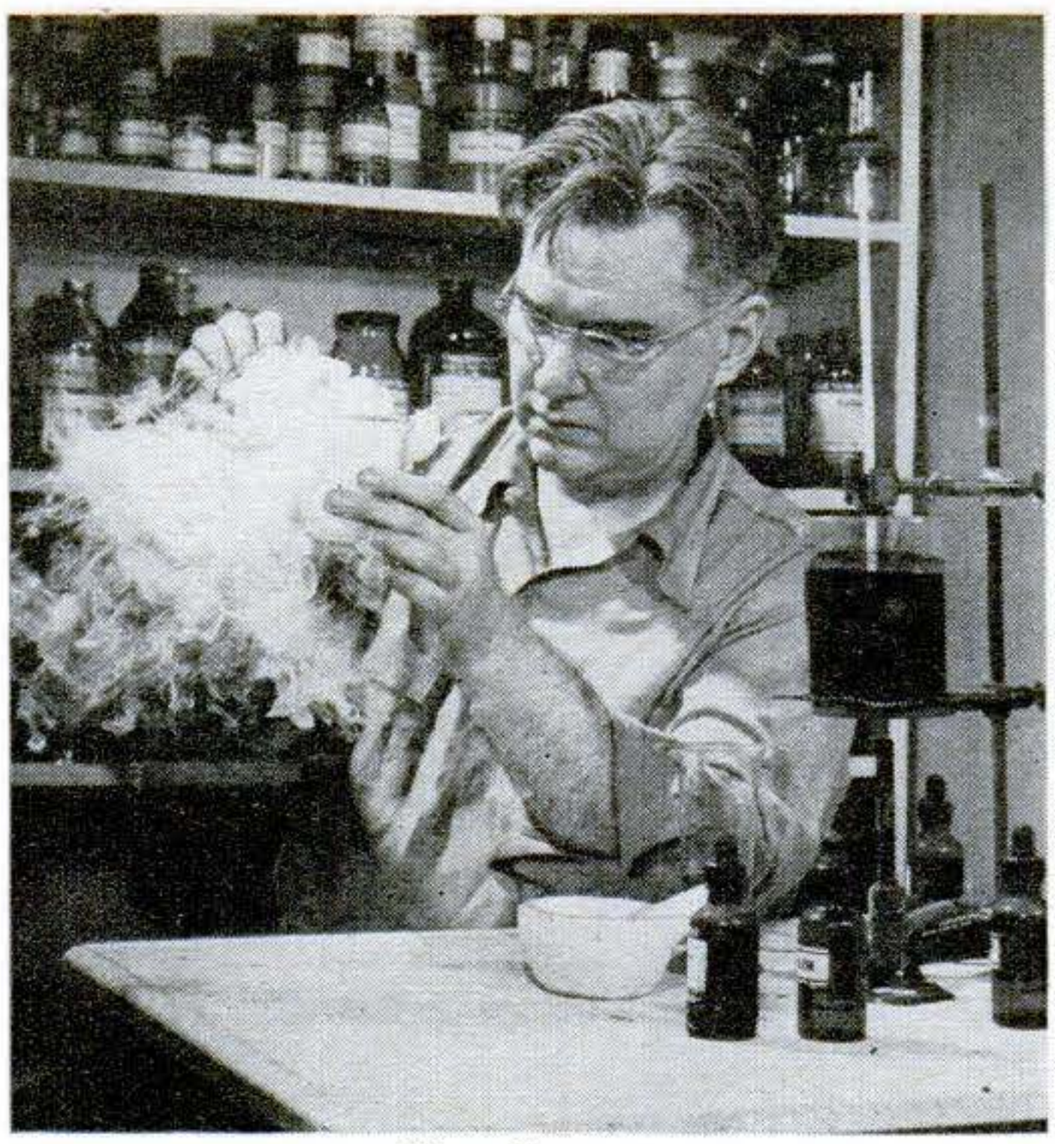
TO: Reader
FROM: Editor

The Home of Home Experiments



Ken Swezey

THE first Tuesday of every month, rain or shine, a chap turns up in the offices of POPULAR SCIENCE with a manuscript and some photographs in one hand and a can of salted peanuts in the other. Without comment, he deposits the peanuts on the desk of the Mechanics & Handicraft Editor. The editor proceeds as wordlessly to read the manuscript and look at the pictures. It is always a race to see whether the editor or his visitor will get the most of the peanuts.

Conversation is needless, because the peanut vendor has been going through this routine for the last dozen years. He is Ken Swezey, author of scores of highly popular PS articles on home demonstrations of basic science. This month he wrote and illustrated "Focusing Your Interest" (p. 235). Last month he took apart a glass of milk. Next month he will tell about cold light.

Ken Swezey is a burly fellow who was born—and still lives—in Greenpoint, Brooklyn. He has been selling articles on science since his grammar-school days. His first, written when he was 11, told how to make a wet cell. It brought him $2.

As a youngster, one of his heroes was Nikola Tesla, the electrical genius. Swezey was 17 when he scraped up an acquaintance. Their close friendship lasted until Tesla's death a few years ago. Troubled by public indifference to Tesla in his later years, Swezey stage-managed a celebration of the inventor's 75th anniversary that snowballed into a world-wide affair. Not long ago the executor of Tesla's estate assigned Swezey the task of sifting the inventor's trunkfuls of notebooks for publication.

Swezey is the editor of a book in his own right—"After-Dinner Science," published recently by Whittlesey House. Albert Einstein wrote Swezey that he found it interesting, and added: ". . . I admired very much the experiment about Archimedes' principle; it was quite new to me." Much of the book is made up of material that first appeared in POPULAR SCIENCE. Many of the photographs (which Swezey shot himself) were recently featured in *Life*.

Publications in South America and Sweden regularly reprint Swezey's home experiments from PS. College professors incorporate his demonstrations in physics lectures. John Kieran, the radio wit and encyclopedist, Lenox Lohr of the Chicago Museum of Science and Industry, and Fred Whipple, the astronomer, have complimented Swezey on them. That his appeal is not only to longhairs, however, can be attested by PS editors. When the pressure for space in the magazine occasionally squeezes out "Home Experiments," a batch of short-tempered letters warns us not to let it happen again.

How does Swezey make science popular? His skill lies in translating an abstraction into a graphic image. He strips the mystery from a perplexing principle and dresses it in everyday garb by demonstrating it with common utensils. It's a neat trick if you can do it. Ken Swezey can.

The Editors

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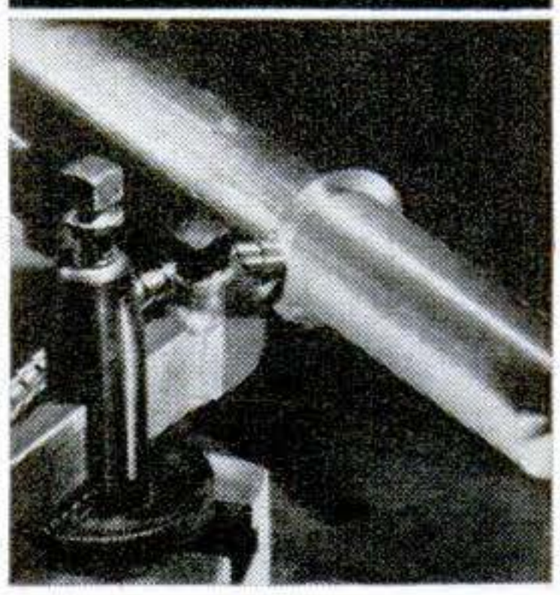
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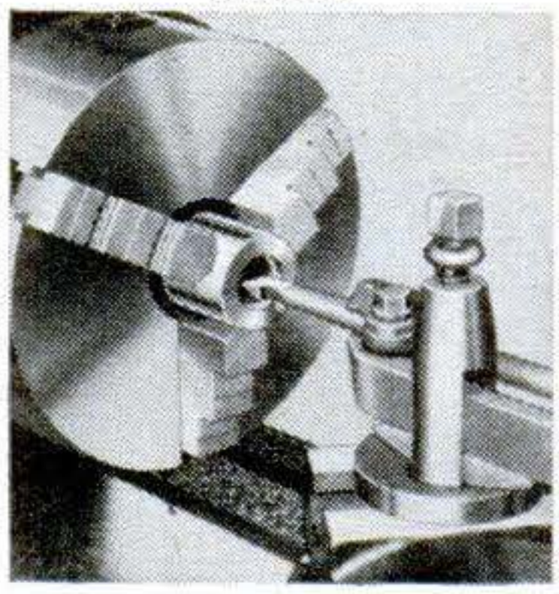
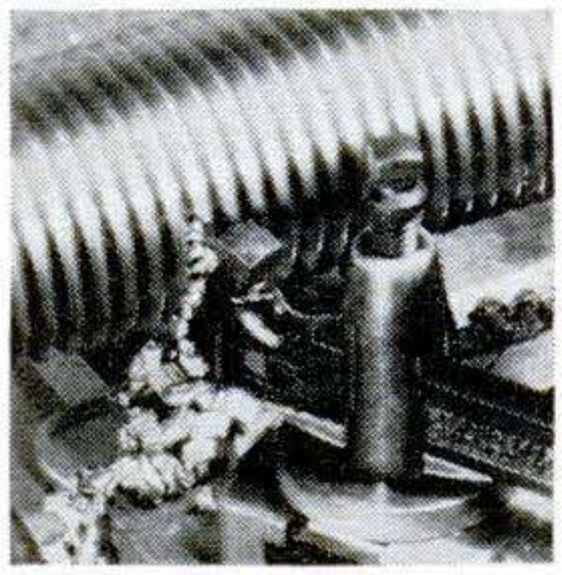

BORING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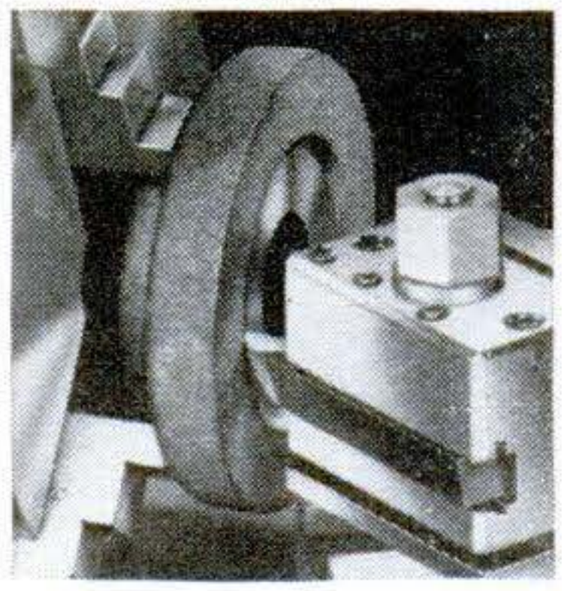
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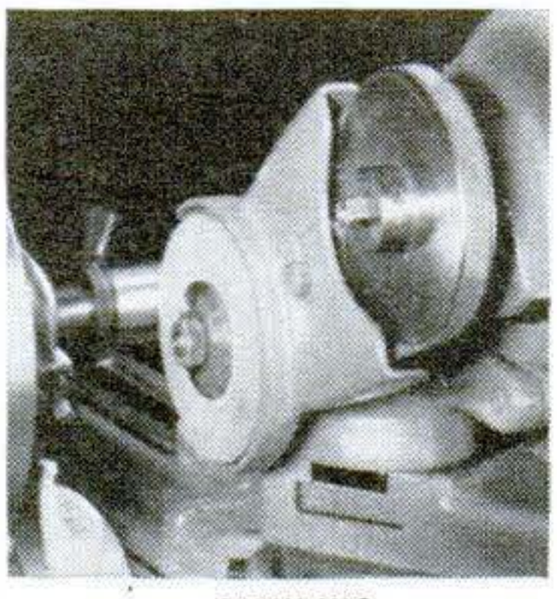
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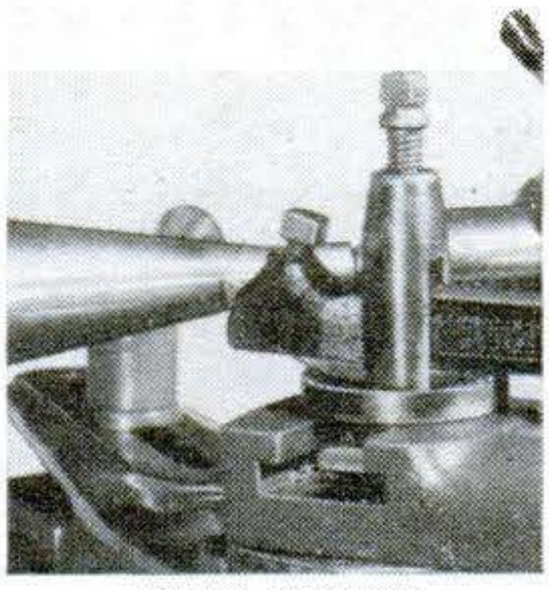
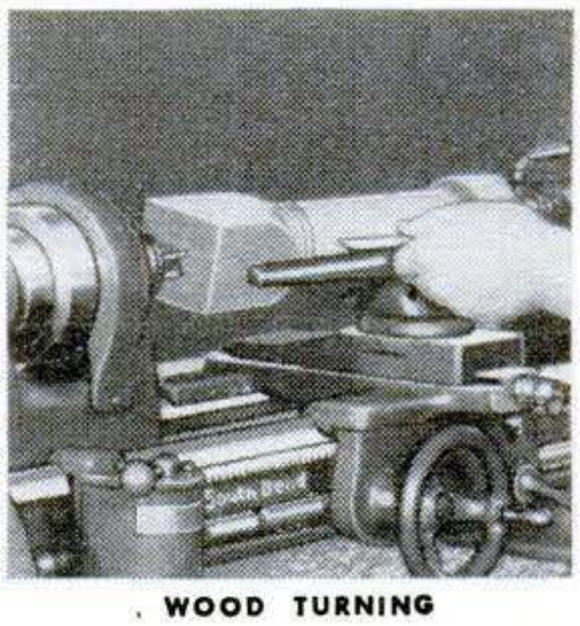

TAPER TURNING


WOOD TURNING

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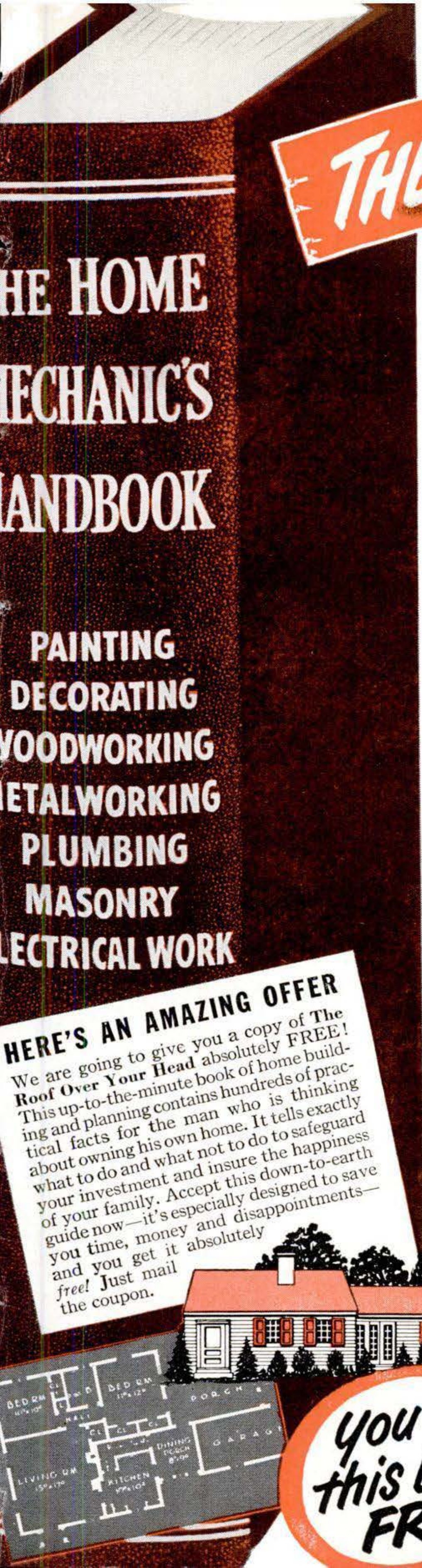

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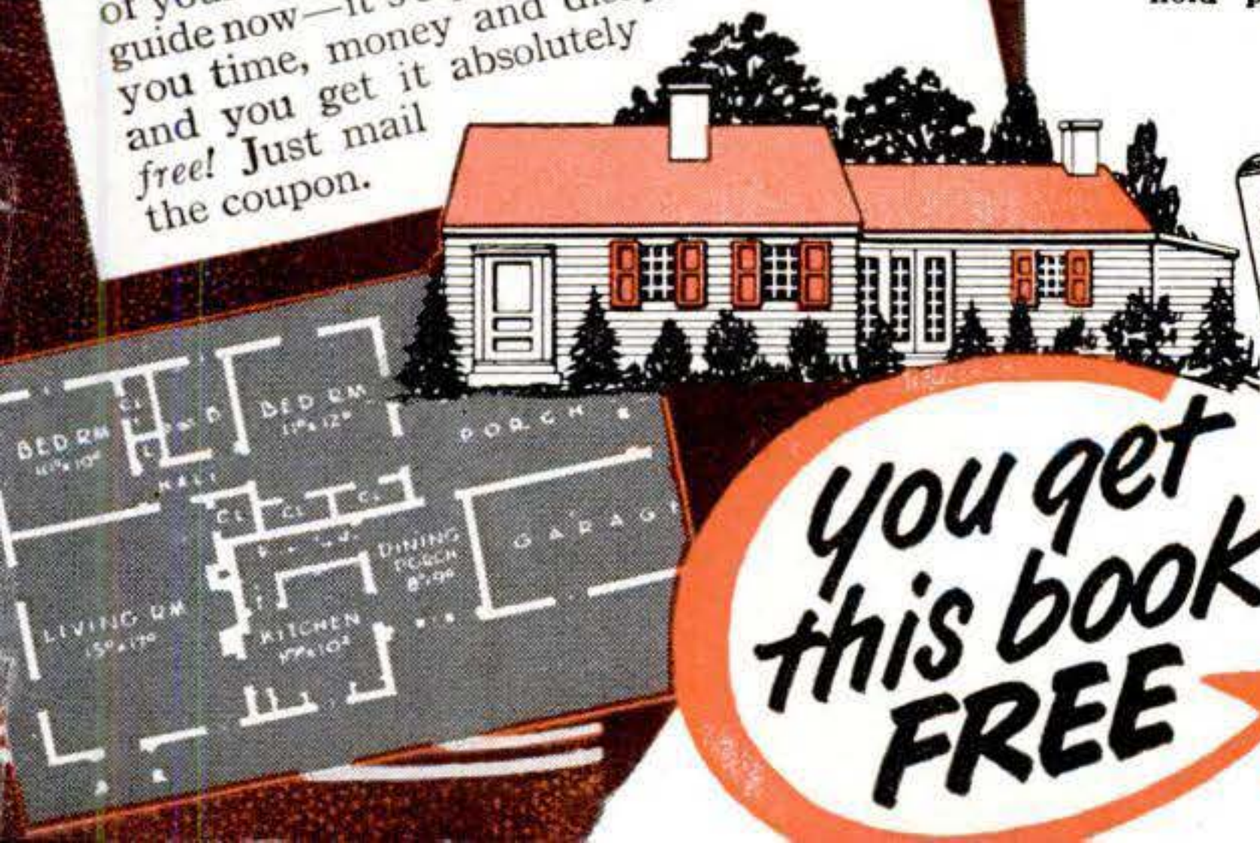

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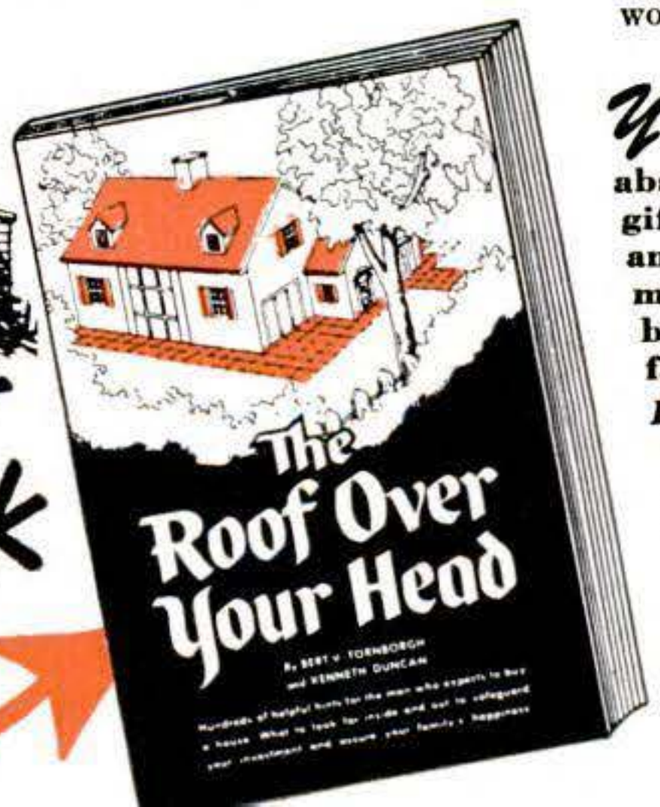

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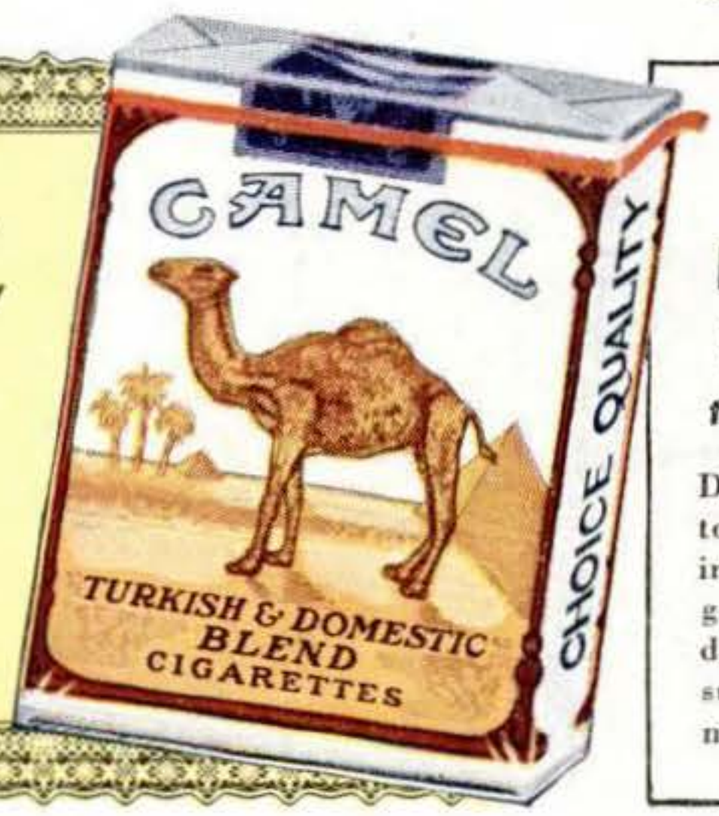

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